PB-230 395

A CATALOG OF RESEARCH IN AQUATIC PEST CONTROL AND PESTICIDE RESIDUES IN AQUATIC ENVIRONMENTS

Smithsonian Science Information Exchange,
Incorporated

Prepared for:

Environmental Protection Agency

May 1972

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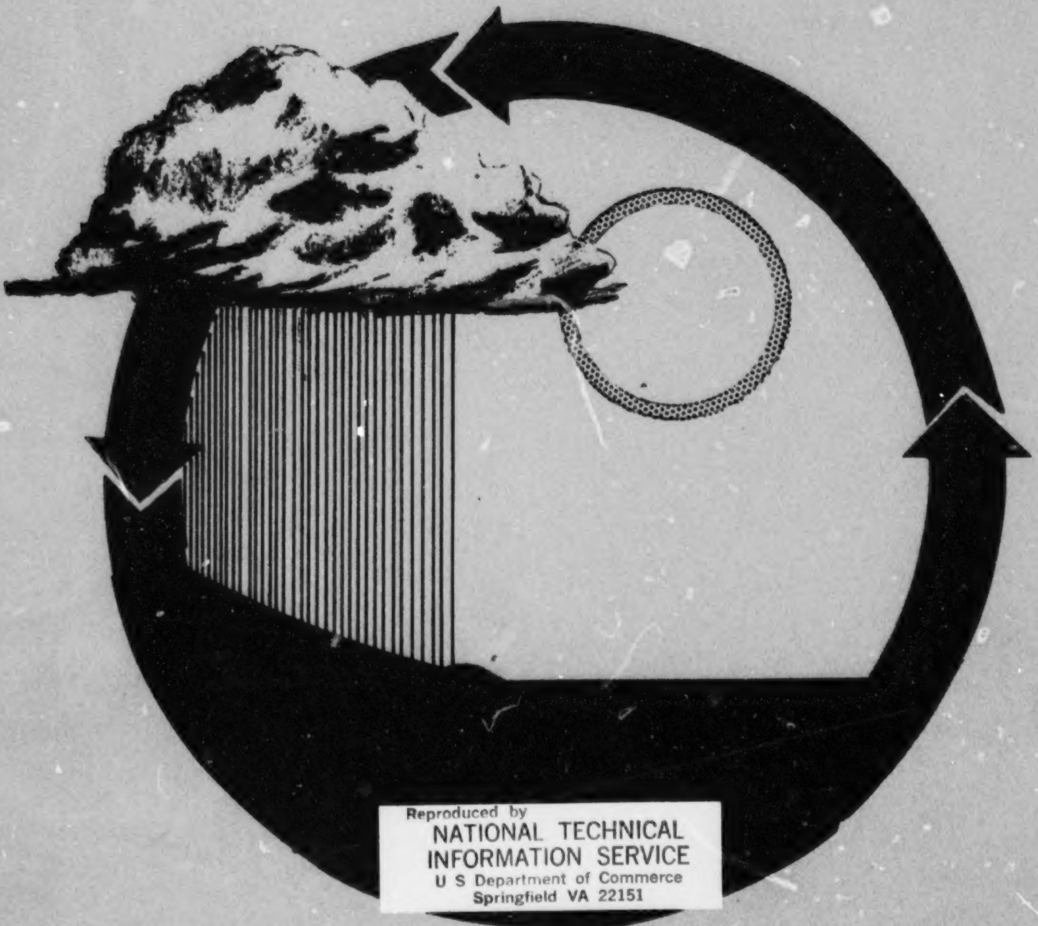

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A CATALOG OF RESEARCH IN AQUATIC PEST CONTROL AND PESTICIDE RESIDUES IN AQUATIC ENVIRONMENTS

358

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PESTICIDE STUDY SERIES — 1

A CATALOG OF RESEARCH IN
AQUATIC PEST CONTROL
AND PESTICIDE RESIDUES
IN AQUATIC ENVIRONMENTS

This catalog is the result of Contract No. 68-01-0349 awarded by the OWP, as part of the Pesticides Study (Section 5(l)(2) P.L. 91-224) to the Smithsonian Science Information Exchange, Inc.

The EPA Project Officer was: Charles D. Reese, Agronomist

ENVIRONMENTAL PROTECTION AGENCY
Office of Water Programs
Division of Applied Technology
Rural Wastes Branch

MAY 1972

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price $2.75
Stock Number 5501-0355

FOREWORD

This catalog prepared by Smithsonian Science Information Exchange, Inc. is part of series concerned with the methods to control the release of pesticides into the environment, the fate and persistence of pesticides in the aquatic environment and alternatives to pesticides. This catalog and subsequent publications in the series was developed under the provisions of Section 5(l)(2) P.L. 91-224.

This catalog is a current listing of the research effort related to pesticides impacting on the aquatic environment.

Editor's Note

Much interest and demand has arisen for a compilation of current research for the area of pesticides and pest control in aquatic environments. Toward this end, the Office of Water Programs of the Environmental Protection Agency contracted with the Smithsonian Science Information Exchange to assemble and prepare a compilation of appropriate pesticides and pest control studies. Special consideration was given to providing a selection of research projects and a subject index which would encompass this broad subject area in a useful form. A total of 884 projects which were active during the FY 1970 and FY 1971 period were included. On the average, 14 subject entries have been included for each project.

Along with the summaries of the projects, the catalog contains the following indexes: Subject Index, Investigator Index, Contracting Agency Index, and Supporting Agency Index. The information which appears in the summaries and the indexes was taken directly from the project record as received by the Smithsonian Science Information Exchange.

The Subject Index is an hierarchical arrangement of index items, indicating relationships between broader and narrower concepts. The index term is followed by the project title, and the chapter identification number of the project. As a further aid in locating subject areas, the first high-level hierarchical term to appear on a left-hand page will be shown in the upper left-hand corner of that page, and the last high-level term to appear on the right-hand will appear in the upper right-hand corner of that page, in dictionary fashion.

The Investigator Index is an alphabetical listing of the investigators listed on the project record. An asterisk designates the principal investigator. Unless specified, the first name listed on the project record was selected as the principal investigator. In several instances it is apparent that the "investigator" denoted on the source document is, in fact, a program manager, who may not be at the institution or location listed with the project record or displayed with the other indexes.

The Supporting Agency Index (indicating funding sources) and the Performing Organizations Index are single alphabetical listings.

All of the Indexes in this catalog were generated by means of a computer, necessitating a limitation on the number of characters available for index terms and captions. Thus, in some instances, abbreviations had to be used.

It is our desire that the users of this catalog further acquaint themselves with the services of the Smithsonian's Science Information Exchange. As a National Registry of Research in Progress, the Exchange receives 100,000 summaries of on-going research each year defining *Who* is planning *What* research, *Where* and *How* supported. We invite your questions and registration of your current research efforts. For additional information, write Smithsonian Science Information Exchange, 1730 M Street, N.W., Washington, D.C. 20036.

Readers are requested to advise the Smithsonian Science Information Exchange of any errors of omission or commission that have been made. Also, critiques of this volume are encouraged so that future editions may present research information in a manner most convenient and acceptable to the user.

David F. Hersey, President
Smithsonian Science Information Exchange

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TABLE OF CONTENTS

Page

FOREWORD iii

EDITOR'S NOTE v

DESCRIPTION OF RESEARCH PROJECTS 1–1

1. Pesticide Residues and Aquatic Environments (movement, persistence, accumulation or degradation, monitoring, and analysis of residues) 1–1
    - 1A. Soil (soil leaching mechanisms, aquifers, groundwater, wells) 1–1
    - 1B. Surface waters (precipitation, surface runoff, streams, lakes, oceans, aquatic sediments) 1–10
    - 1C. Fish and shellfish (residues in tissues) 1–43
    - 1D. Food chains (residues or effects in aquatic food chains from nannoplankton to birds and man) 1–47
2. Aquatic Pest Control (target oriented use of chemical, biological, cultural, mechanical or physical control methods) 1–65
    - 2A. Aquatic insects 1–65
    - 2B. Aquatic weeds (submersed, floating, amphibious, or riparian plants and aquatic algae) 1–83
    - 2C. Fish (control of lamprey or rough fish or the chemical manipulation of fish populations for sampling harvesting or transferring purposes) 1–101
    - 2D. Snails and other aquatic pests or predators (control of marine mollusks, freshwater or land snails, bird or mammal predators) 1–114
3. Fish and Shellfish Pathology 1–121
    - 3A. Epidemiology (no control or treatment evaluated or suggested) 1–121
    - 3B. Treatment or control measures (emphasis may still be on epidemiology) .. 1–136
4. Aquatic Pest Ecosystems (phenology, life history, habitat, distribution and classification) 1–143
    - 4A. Aquatic algae and aquatic vascular plants 1–143
    - 4B. Aquatic insects 1–148
    - 4C. Fish and shellfish 1–156

SUBJECT INDEX 2–1

PRINCIPAL INVESTIGATOR INDEX 3–1

PERFORMING ORGANIZATION INDEX 4–1

SUPPORTING AGENCY INDEX 5–1

DESCRIPTION OF RESEARCH TASKS

1. PESTICIDE RESIDUES AND AQUATIC ENVIRONMENTS

(Movement, Persistance, Accumulation or Degradation, Monitoring, and Analysis of Residues)

1A. SOIL (Soil Leaching Mechanisms, Aquifers, Groundwater, Wells)

1.0001, LEACHING OF SELECTED HERBICIDES IN ALABAMA SOILS

A.E. HILTBOLD, Auburn University, School of Agriculture, *Auburn, Alabama* 36830

The objectives of the proposed research are to determine the leaching and dispersion characteristics of picloram, 2,4,5-T and methanearsonate herbicides in several Alabama soils. Both field plots and laboratory soil will be used. The laboratory and field characteristics needed to classify these soils will be obtained. The results should help elucidate some of the significant soil, herbicide and environmental factors which affect herbicide movement.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0002, INACTIVATION AND LOSS OF PESTICIDES FROM SOIL

A.E. HILTBOLD, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00200)

OBJECTIVE: Determine inactivation and loss of pesticides from soil by volatilization, microbial degradation, non-microbiological degradation, movement of water through or over soil, for the purpose of identifying primary loss processes, relating these processes to soil properties, and predicting pesticide persistence.

APPROACH: Relative biological and non-biological breakdown of atrazine will be determined by measurement of hydroloysis of labeled atrazine in soil samples incubated with normal microflora and in autoclaved samples of these soils. Volatilization and microbial degradation of fluometuron and trifluralin will be determined in soil samples with C labeled herbicide during incubation in controlled air streams. Field experiments will provide bioassay data on persistence of preplant applications of atrazine, trifluralin and nitralin. Analysis of field plot soils and harvested crops will provide information on movement and uptake of arsenic from methanearsonates.

PROGRESS: Processes of retention and loss of benefin (N-butyl-N- ethyl-alpha,alpha,alpha-trifluoro-2,6-dinitro-p-toluidine) were investigated. Benefin was placed at precise depth in Orangeburg, Greenville and Dothan loamy sands in the field, then soil samples were obtained at intervals during the season. During the first 2 weeks the original 20 ppm of benefin decreased to 10 ppm while the untreated soil above and below acquired 1 ppm of benefin. Despite 19' of rainfall benefin was not found deeper than 1' below its position of placement. A monodealkylated degradation product appeared in deeper soil layers late in the season. Laboratory incubation of these soils containing (C)-labeled benefin showed slow biodegradation of benefin. Increasing microbial activity with added organic matter stimulated benefin degradation. Primary loss process of benefin was found to be volatilization to the atmosphere. Leaching played little or no part except to move degradation products downward. At normal use rates for weed control in peanuts, benefin did not persist into the fall and residues in the soil were nonphytotoxic.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0003, FATE OF HARMFUL METALS IN SOIL AND WATER SYSTEMS

W.E. NELSON, Tuskegee Institute, George W. Carver Res. Found., *Tuskegee Institute, Alabama* 36088

No summary has been provided to the Science Information Exchange.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - E.H.S.

1.0004, CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS

T.N. JOHNSEN, U.S. Dept. of Agriculture, Crops Research Division, *Flagstaff, Arizona* 86003 (0710-04-02)

OBJECTIVE: To develop and evaluate control methods for use on junipers, shrub live oak, and associated species as part of a broad national program to develop principles and practices on control of weeds and brush under various climatic conditions.

APPROACH: Studies include field, laboratory and greenhouse experiments on methods of controlling brush and weed species that are problems on grazing lands and will include studies of herbicides and their ecological, physiological and agronomical aspects as they affect rangeland brush and weed populations and the resulting ecological impact on desirable vegetation. Studies include some aspects of fate of herbicides when applied to watershed areas.

PROGRESS: Picloram injected into a small stream at the rate of 5 ppmw for 50 minutes had downstream picloram concentration peaks of 2.5 ppm at 1/4 mile, 0.9 ppm at 1/2 mile, 0.34 ppm at 1 mile, 0.01 at 2 miles, 0.002 ppm at 4 miles and not detectable at collection points further downstream. Picloram was not detectable from water and soil samples collected downstream of the injection point after 48 hours and during the remainder of 1969. Broadcast burning of chaparral vegetation 2 months after aerial spray treatment reduced the soil picloram content from 1.1 to 0.2 lb/A. Unburned plots had little or no change in picloram content during the same time interval. Damage on vegetation indicated m-(3,3-dimethylureido)phenyl-tert-butylcarbamate has moved as much as 200 feet off of 1/10 acre-sized plots treated with a granule formulation on clay soils. Evidence of herbicide movement from spot applications of this herbicide were less. The herbicide effectively controls shrub live oak, gambel oak and Utah juniper at 4 to 8 lb/A, broadcast on the soil.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

1.0005, WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST

A.R. HIBBERT, Arizona State University, U.S.D.A. Rocky Mtn. For. Sta., *Tempe, Arizona* 85281 (RM1609)

OBJECTIVE: Improve water yield by converting chaparral to other vegetation cover without increasing erosion or pollution.

APPROACH: What are effective measures for converting chaparral to other vegetation cover to increase water without increasing sediment or pollution. Effectiveness of cover changes on water and sediment production is being determined at a network of small experimental watersheds in the chaparral. Water-using characteristics of chaparral plants are not understood. The water-using characteristics of chaparral plants are being studied in the laboratory and field to find ways of reducing and controlling transpiration. Effects of conversion on the ecology of natural chaparral cover does not exist. Ecology of the native cover is being studied in the field and laboratory to understand structural and successional patterns and to determine effective methods of shrub control and cover conversion.

PROGRESS: Converting brush to grass in Arizona chaparral substantially increases water yield and creates permanent flow in previously intermittent streams. Streamflow on 3 small experimental catchments has increased as much as 3 times pretreatment yields depending on rainfall, soils, and brush density. Fenuron contamination of stream water remains low following application of 23 pounds active fenuron per acre in pelleted form to the soil surface in a strip 75 feet each side of stream channels comprising 38 acres or 15% of the total watershed area. The highest concentration was 0.43 ppm 33 days after treatment following heavy rains. Trace amounts of fenuron were still present in the stream water 27 months after treatment. About 2.4% (21 pounds) of the applied chemical left the catchment via streamflow during 27 months in which rainfall totaled 50 inches and streamflow 4.4 inches. Quantitative bioassay tests have shown that granular Tandex at 20 pounds active ingredient per acre penetrates faster and deeper in sandy ridge- top soil than in finer soils with more organic matter located at the base of slopes. After 8 months and 9.8 inches of rain, Tandex was present to depths of 12 to 30 inches, depending on these soil properties, in amounts which were lethal to oats.

SUPPORTED BY U.S. Dept. of Agriculture - F.S.

1.0006, PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS

G.R. DUTT, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-2020-4151-018)

OBJECTIVE: Identify the physical-chemical properties of pesticide- soil-water systems. Develop a mathematical model which will provide semiquantitative predictions of pesticide movement in soil-water systems.

APPROACH: Carbon 14 labeled Picloram, 2,4-D, 2,4,5-T will be solubilized in aqueous solutions of different ionic composition and concentrations over a range of temperatures. Using data from other cooperation stations and the above, a system analysis model will be developed.

PROGRESS: A model for calculating the distribution and soil solution concentration of atrazine was altered to take into account the change in solubility of atrazine with solutions of electrolytes, the difference in sorption and desorption isotherms, and the change in distribution coefficient with different ratios of Na, Ca, and Mg. The data from leaching studies are being compared with theoretical results. These correlations seem to confirm that the above findings are responsible for the tailing off of breakthrough curves.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0007, PESTICIDE RESIDUES ON ARIZONA CROPS

G.W. WARE, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-0800-255-542)

OBJECTIVE: Investigate the deposition and metabolism of pesticides by animals, plants and microorganisms. Investigate the interrelations of crops, soil, air and water as they influence pesticide deposition.

APPROACH: Metabolism and deposition studies will involve normal and radio-labeled insecticides to be detected by liquid scintillation, thin layer and gas chromatography. These include all classes of insecticides, to be investigated in the lab, greenhouse and field. Crop residues will be determined and correlated with soil and water residues to isolate the contribution of each by quantitating pesticide additions to soils directly through application, irrigation and canal systems, and indirectly from field effluents into others, and the resulting crop residues from routes other than deliberate application.

PROGRESS: Two water plants, Cladophora, a filamentous alga, and Potamogeton, a pondweed known as sage, would serve as good indicators of water contamination by DDT and related metabolites. They have an apparent concentrating characteristic greater than other plants, are easily collected, and occur in most irrigation canals. From what has been learned regarding the wide distribution of DDT and DDE, and the recent history of heavy DDT use in Arizona, alfalfa grown in the intensively cultivated irrigated areas probably will bear detectable residues of these compounds for the next several years, even if the use of DDT is discontinued. Extraction of hay samples for DDTR with a solvent combination of chloroform:methanol (1:1) is the most exhaustive method found to date.

SUPPORTED BY Arizona State Government

1.0008, INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS

D.A. BROWN, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville, Arkansas* 72701 (ARK00657)

OBJECTIVE: Evaluate the effect on solubility and adsorption of pesticides in soil containing various concentrations of fertilizer materials, determine the degradation rate of pesticides in soil containing differing amounts of fertilizer materials, and predict the potential effect of results found under objectives 1 and 2 on the quality of water which may be used as domestic, recreational, and agricultural water supplies.

APPROACH: The solubility and adsorption of four pesticides, Aldrin, Prometryine, Trifluarlin, and Amiben will be measured in three soils, Crowley silt loam, Sharkey clay, and Dundee silt loam at two rates each of the fertilizers: ammonium nitrate, fertilizers. Ammonium sulfate, anhydrous ammonia, urea, potassium chloride, triple superphosphate, and limestone. Solubility of the pesticides will also be measured in pure water and in aqueous solutions of the fertilizers. Radioactive-tagged pesticides will be used, in these studies. Degradation of the pesticides of the soil-pesticide fertilizer combinations will be measured with gas chromatography techniques.

PROGRESS: The chemical, physical, and mineralogical analysis of Dundee silt loam, Crowley silt loan, and Sharkey Clay were completed. The effect of 6 nitrogen rates for 5 sources of nitrogen upon the adsorption of Prometryne, Aldrin and Fluometuron over four time periods was completed. The effect of (NH(4))(2)SO(4), NH(4)NO(3) and Nitrane upon the diffusion of Fluometuron in agar, glass beads and Crowley silt loam was also measured. Adsorption of pesticides increased as the time of fertilizer-pesticide interaction was extended. The greatest adsorption of Aldrin and Prometryne was by Sharkey, followed by Crowley and Dundee. Increasing rates of Nitrogen increased and decreased adsorption depending upon changes in pH and salt content. The diffusion of Fluometuron in Crowley silt loam was affected by Nitrogen sources, rate, and time of interaction. The movement was ten times slower than in glass beads or agar, indicating that a soil-fertilizer-fluometuron interaction was present. The adsorption and diffusion of these pesticides was found to be a very critical function of pH, salt content, and time of interaction.

SUPPORTED BY Arkansas State Government - Little Rock

1.0009, INACTIVATION AND LOSS OF PESTICIDES FROM SOIL

R.E. TALBERT, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville, Arkansas* 72701 (ARK00633)

OBJECTIVE: Determine inactivation and loss of herbicides from soil by volatilization, retention and release, and movement of water through soil for the purpose of identifying primary loss processes, relating these processes to soil properties, and predicting herbicide persistence.

APPROACH: The physical-chemical aspects of selected herbicides with respect to their inactivation and loss from soils will be studied; Volatility under controlled laboratory conditions utilizing vapor trapping devices to trap samples for chemical and biological analysis, retention and release using adsorption isotherms and diffusion methods, and movement using soil column techniques.

PROGRESS: Studies on the fate of nitralin in soils were continued. The loss of nitralin- C from metal planchets under various conditions was determined. At temperatures less than 35 C in the dark, nitralin- C was not lost over a 150 hr period. However, at higher temperatures increasing amounts were lost, 50% in 40 hr at 72 C. Protection of nitralin - C samples in metal planchets with plastic which absorbed in the UV region, reduced the loss of nitralin to 32% as compared to 43% loss in full sunlight over a 35 hr period. The leaching of nitralin in Loanoke fine sandy loam was determined in slotted leaching columns using the crabgrass bioassay. Nitralin was applied to the surface of the columns or incorporated into the upper 5 cm of air dry or 15% moisture soil and (a) not leached, (b) leached immediately, or (c) leached after 2 days with 10 cm of water. There was generally little movement of the nitralin indicated. The surface application moved about 3 cm. With incorporation into dry or wet soil and immediate leaching or leaching after 2 days, movement was generally less than 1 cm. The inactivation and persistence of nitralin, 1 lb/A, and fluometuron, 1 1/2 lb/A as affected by activated charcoal (500 lb/A Darco S-51) was studied under field conditions. The charcoal completely inactivated both herbicides during the growing season as indicated by the sensitive species grown in these plots. There was only a slight decrease in herbicidal activity throughout the season where no charcoal was applied indicating that phytotoxic residues of both compounds remained at least past one growing season.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0010, EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION.

K.H. BOWMER, Comm. Sci. & Indus. Res. Org., *Griffith, New South Wales, Australia*

Object: 1. Atrazine, diuron, fluometuron, trifluralin herbicides. a) Investigate possible hazards of over persistent residues to crops intense rotations (rice, cereals, sorghum, maize, sunflower, soybean, safflower, cotton). b) Investigate possible hazards of over persistent residues to crops intense rotations (rice, cereals, sorghum, maize, sunflower, soyabean, safflower, cotton). b) Investigate instances of inefficient weed control. c) Investigate less persistent alternatives e.g. thiolcarbamates. 2. Investigate fate of bromacialherbicide in citrus orchard soil.

Approach: Initially, atrazine and bromacil. Monitor residues in soil where history of application is well-documented. Field studies of atrazine activity and persistence under maize. Laboratory studies with contrasting soil types of adsorption, leaching, persistence of herbicides. Effects of clays, organic matter, pH, temperature and water content on rate and pathway of breakdown.

SUPPORTED BY Australian Government - Canberra

1.0011, MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS

J.P. MARTIN, Univ. of California, Agricultural Experiment Sta., *Berkeley, California* 94720 (SWC-024-BELT-12)

OBJECTIVE: Determine the method of movement of chlorinated hydrocarbon insecticides in soils and evaluate the influence of soil properties, temperature, humidity, and soil-water content on movement, particularly vapor-phase movement, and volatilization losses into the atmosphere.

APPROACH: Laboratory experiments will be conducted to evaluate the influence of various soil and environmental factors on movement and volatilization of chlorinated hydrocarbon insecticides. Commonly used insecticides such as DDT, lindane, dieldrin, aldrin, etc., will be added to soils typical of Southwestern semi-arid areas. Rate of movement from a treated to an untreated portion of the soil will be used to calculate diffusion coefficients and predict movement under various field conditions including losses to the atmosphere by volatilization which would occur after application of insecticides in the field.

PROGRESS: A theory was developed to describe the combined vapor and nonvapor' phase diffusion of a volatile insecticide in soils and compared with the diffusion of lindane in a Gile silt loam. At a 10% soil-water content, 50% of the lindane diffuses in the vapor phase and 50% in the'nonvapor' phase. At near saturation, total diffusion is in the 'nonvapor' phase. The diffusion coefficient for lindane in a Gila silt loam is nearly zero at 1% soil-water content and increases rapidly to a maximal value at 3% water content. Decreasing bulk density or increasing temperature raises the diffusion coefficient. The influence of soil-water content, relative humidity, air flow rate and insecticide concentration on the volatility of lindane from soil surfaces is being determined. The influence of soil type on lindane diffusion is being measured. All of the above information will be combined to predict the fate of pesticide residues in soils.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0012, SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL

J.W. BIGGAR, Univ. of California, School of Agriculture, *Davis, California* 95616

Necessary information linking the reactions between pesticide and soil, and pesticide and plants, to the characteristics of each other, the soil solution environment, temperature and water movement is very spotty and incomplete. Thus this proposal is for a project to obtain a reasonable amount of related information on typical soils and selected pesticides related to fixation and movement. Depending upon the type of soil, organic additive and environment, a number of reactions will determine the extent of movement and persistence in soils. The organic additive may be absorbed by soil, exchanged, absorbed by plants, decomposed into more or less mobile, toxic products, precipitated or leached into ground water, drainage water and streams.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

1.0013, PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS

J.W. BIGGAR, Univ. of California, Agricultural Experiment Sta., *Davis, California* 95616 (CA-D0-WSE-2298-RR)

OBJECTIVE: Identify and characterize the physical-chemical properties of the pesticide-soil-water system which are pertinent to pesticide transport through the soil in infiltrating water, and pesticide desorption from eroded soil into surface waters. Measure pesticide transport through and over soil in the field or in lysimeters, using well characterized initial and boundary conditions.

APPROACH: The thermodynamics of soil pesticide interactions in water will be studied using equilibrium techniques and radioactive pesticides. The kinetic studies will involve dynamic systems both of a steady state and transient nature. Field investigations involve pesticide movement in well defined plots in which water and pesticide movement are monitored over periods of weeks. In some cases, overland flow may be examined in selected watershed areas. The investigators cooperating on this objective will work closely with those developing models to assure the maximum usefulness of field data. California will be making field measurements with the carboxylic acid herbicides on the soils.

PROGRESS: Work has been extended and now completed on the persistence and recovery of four chlorinated hydrocarbons from five California soils involving six extraction methods which include 12 solvent or combinations of solvents. Hexane 2-propanal (1:1) appeared to give the best all-around extraction. Pesticide loss appeared to follow a first-order reaction. The Hiester-Vermuelen rate model for the displacement and removal of pesticides is being examined as a possible useful predictive model for pesticide behavior. Calorimetric results of last year were reexamined and found to be essentially the same with important differences between the Ca and Na-illite systems. Solubility measurements on six organo-phosphate pesticides at 15, 25, and 35 C. have been completed for ionic solution concentrations of 0.01 and 0.05N CaCl(2) and NaCl.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0014, DEVELOPMENT OF A TECHNIQUE FOR THE CONTROLLED SELF-DESTRUCTION OF FIELD-APPLIED DDT

K.H. SWEENY, Aerojet General Corporation, *El Monte, California* 91734 (14-12-922)

Description: The ultimate objective is the development of a system for the controlled degradation of field-applied DDT by the use of integrated microcapsules containing both the pesticide and degrading chemicals which are activated upon exposure to air, water, or soil. The feasibility of this concept has been demonstrated by work recently completed under FWQA contract 14-12-596. The immediate objective of this contract is to optimize the degradation system and to determine the toxicity of the degradation products on fish.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0015, INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES

F.L. TIMMONS, Stanford Research Institute, *Menlo Park, California* 94025 (0710-02-10(C))

OBJECTIVE: Determine the presence and concentrations of selected herbicides and degradation compounds and metabolites in water, soil, and in greenhouse-grown crops irrigated with water containing known concentrations of each herbicide.

APPROACH: Potatoes, carrots, onions, tomatoes, romaine lettuce, soybeans and milo will be grown to maturity in the greenhouse. Amitrole-T, 2,4-D, dalapon, silvex, dichlobenil, diuron, and simazine will each be applied to two concentrations to irrigation water to be applied by overhead sprinkle and bottom flooding methods to each crop at an early fruiting vs. late fruiting stage. Samples of treated water will be taken at time of irrigation and samples of the soil will be taken a few days later. Samples of edible portions of treated crops will be taken at maturity. All samples will be analyzed by appropriate methods to determine concentrations of each herbicide and of important metabolites. Diquat and endothall may be substituted for diuron and simazine.

PROGRESS: All six crops have been grown, irrigated with treated water, and samples of edible parts taken at normal harvest time and processed for analyses. Analyses were completed for silvex, 2,4-D, dalapon, and amitrole. Average maximum concentrations (ppm) of 2,4-D residues found in the various crops irrigated with water containing the highest concentration were as follows: potatoes, 0.03 to 0.12; milo, 0 to 0.12; carrots, 0.02 to 0.06; soybeans, none; leaf lettuce, 0.11 to 0.33; onions, all below 0.05. Residues of silvex (ppm) from the highest concentrations of silvex in treated water were: potatoes, 0.03 to 0.3; milo, none; soybeans, 0.09 to 0.17; carrots, none; lettuce, none; onions, none. The residues of dalapon (ppm) from the highest concentration were: potatoes, 0.04 to 2.7; milo, 0.05 to 0.53; soybeans, 0.6 to 1.9; carrots, 0 to 0.81; lettuce, 0.05 to 1.13. No amitrole residues were found in any crop except the 0.09 ppm in milo grain from sprinkler irrigation with water containing 0.44 ppm of amitrole. The highest concentration of each herbicide was much greater than those found after normal applications for weed control. Maximum residues of dalapon or 2,4-D found in any crop were much lower than FDA tolerances on several food crops.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

1.0016, VOLATILIZATION LOSSES OF PESTICIDES FROM SOILS

W.J. FARMER, Univ. of California, School of Agriculture, *Riverside, California* 92502

In recent years the importance of vapor phase movement of pesticides has become increasingly apparent. This has particular significance when the potential for rapid widespread distribution in the atmosphere is considered. This widespread pesticide distribution may result in contamination of waters far removed from the site of original application. The objectives of this project are to determine the soil and environmental factors of the soil-water-air system which affects volatilization losses of pesticides from soils and to develop a model which will allow prediction of volatilization losses from pesticide treated areas.

The first objective will be met by examining the volatilization of representatives from several pesticide groups as affected by soil water content, pesticide concentration, air flow rate, humidity, formulation, temperature, soil incorporation, crop cover, soil pH, soil organic matter content and soil clay content.

In the second objective an attempt will be made to relate quantitatively the volatilization losses of a pesticide to the vapor pressure and molecular weight of that pesticide and the volatilization loss of a known compound such as water or another pesticide.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0017, RESPROUTING OF CHAPARRAL

J.R. GOODIN, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-PLS-2184-H)

OBJECTIVE: Attempt to develop an understanding of the phenomenon of resprouting in chaparral species and the autecological, anatomical, physiological, and genetic factors which influence this phenomenon.

APPROACH: The research will be conducted in the field, greenhouse, and laboratory, studying phenology, rate of resprouting, anatomy, growth and development in vitro, carbohydrate levels, and genetic variability of the dominant chaparral species.

PROGRESS: Tandex continues to look more promising than picloram in many situations for the control of Quercus dumosa. Phytotoxicity to grasses has been a serious detriment to the use of this chemical, and studies are in progress for use of the grid application technique to avoid damage to surface vegetation. Final analyses of the experimental watersheds treated with combinations of 2,4-D, 2,4,5-T, and picloram show that essentially all residues have disappeared from the water and soil. A careful study of initial succession of vegetation following these treatments suggests that low residue levels may be phytotoxic to a few species, but in general, the pattern of succession approximates that which occurs following wildfires. Such information will be of use to land planners concerned with long-term ecological effects of herbicides. Studies of the polar transport of auxin are continuing in sterile culture. The new oxygen combustion method for C-determinations will be employed to study quantitative and qualitative changes in growth regulators. A selective bioassay was devised to evaluate extremely low concentrations of picloram in soil and water. This assay is selective for picloram, and is not confounded with effects from phenoxy-type herbicides.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0018, ANALYTICAL METHODS FOR PESTICIDES IN SOIL AND WATER

F.A. GUNTHER, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2407)

OBJECTIVE: Develop dependable, quantitative extraction procedures for removing pesticide residues from samples of water. Develop methods of analysis that will identify and measure the pesticides present, and that are sufficiently sensitive to permit the use of smaller samples than are now required. Automate the analytical procedures as far as practical to achieve maximum output per man-hour.

APPROACH: Carbon columns and other adsorbing media will be investigated, as well as counter-current partitioning procedures. Analytical methods, and particularly instrumental methods that are susceptible to automation, will be developed and adapted to use for water and soil analysis.

PROGRESS: An automated procedure to determine triazine herbicides in soil was developed and a publication is in preparation. The soil sample is introduced into the machine without any preliminary treatment, an important breakthrough for this type of analysis. A similar procedure for determining DDT in soil is approaching completion. A means for distinguishing between DDT and polychlorinated biphenyls was developed and tested on animal tissue samples. There is a striking dissimilarity in responses of the two types of compounds and the method appears a much-needed means for removing doubts about the presence or absence of DDT. Specialized apparatus for extracting pesticides from water was constructed for use in this particular research.

SUPPORTED BY California State Government - Sacramento

1.0019, RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT

F.A. GUNTHER, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2296-RR)

OBJECTIVE: Establish, evaluate, and integrate the physical fates of selected pesticide chemicals in soils, soil water, root crops, and small aquatic organisms that are involved in food chains; develop necessary analytical methodology for these measurements and characterizations.

APPROACH: Selected currently important pesticide chemicals will be studied by physical-chemical and biochemical methods in 50 soil types in both field and laboratory in terms of sorption kinetics, effects of microorganisms, light, temperature, aeration; or leachability by water; or migration to root crops via soil water suspensions; and their acquisition from soil water suspensions by algae, small shrimp, small fishes, and amphibians.

PROGRESS: The persistence of the herbicide Planavin in different soil types was studied under aerobic and anaerobic conditions. The herbicide was lost rapidly from submerged Hanford sandy loam soil but very slowly from other soil types. Several degradation products have been detected and efforts to identify them are in progress. Irradiation with ultraviolet light yielded two major photodecompositon products that have been isolated but not yet characterized. The decomposition of endrin on 10 different air-dried soils was studied and found to vary widely from soil to soil although quite rapid in all types. The addition of water to moisten the soil prevented the decomposition during the period of the study (96 hours). Carbon-skeleton gas chromatography of DDT and some Aroclors (polychlorinated biphenyls, triphenyls, or mixtures of these) was investigated as a means of differentiating between p,p'-DDT and the Aroclors. The dissimilarity in responses was striking and the procedure offers a simple and reliable means for removing the doubts that arise in many instances where DDT is indicated by gas chromatographic responses, yet there is reason to doubt its presence. The Schechter-Haller colorimetric test was also compared for DDT and the Aroclors. At the wavelength normally used for determining DDT, interference by Aroclors was negligible. This reaction, therefore, affords a reliable supplementary test for the presence of DDT.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0020, REACTIONS OF PESTICIDES WITH SOILS

J.P. MARTIN, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2406)

OBJECTIVE: Study the incorporation of pesticides into the stable soil humus; the mechanisms of the occasional temporary toxic effects of pesticide in soil; the mechanisms of pesticide absorption and desorption by soil constituents; mechanisms of increases in soluble or extractable inorganic ions in soil following pesticide applications; absorption, transportation, and accumulation of selected pesticides in plants and the influence on plant growth and metabolic functions; and the influence of soil exchangeable cation ratios and metal salts of selected pesticides on decomposition in soil.

APPROACH: The work will involve plant culture in soils and nutrient solutions in the greenhouse and in growth chambers; and soil treatment and incubation in the laboratory. In addition to the usual analytical procedures, gas chromatographic, carbon 14 analysis with a liquid scintillation counter, and infra-red techniques will be used.

PROGRESS: Studies of lindane diffusion at various moisture contents and ambient pressures revealed that diffusion occurred along four major pathways: air-space, air-water interface, water-water pathway, and water-solid interface. The vapor and water-water pathway components were readily described by normal gaseous equations, and ion diffusion equations, respectively. The quantity diffusing along the air-water interface was proportional to the area of the air-water interface. Volatilization loss of dieldrin from Gila silt loam increased with increasing concentration, air flow rate, relative humidity, soil water content, and temperature. Losses ranged from 4mg/cm/day up to 600mg/cm/day. Maximum dieldrin loss occurred at 100% relative humidity when no water loss was occurring from the soil. Thus water loss is not necessary for dieldrin volatility to occur. The ratio of DDT:dieldrin:lindane loss was 1:5:17 for both 5 and 10 ppm at 30C. The volatility results indicate that potential insecticide losses under field conditions due to volatilization may account for a significant proportion of the total loss. Methods of reducing DDT levels in contaminated agricultural fields are under investigation. In one case, deep plowing to 24 inches has been used to dilute the insecticide and to remove it from the root zone. Soil and crop samples are being analyzed as a measure of the method's effectiveness.

SUPPORTED BY California State Government - Sacramento

1.0021, REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST

W.F. SPENCER, Univ. of California, U.S.D.A. Soil & Wa. Cons. Div., *Riverside, California* 92507 (SWC-024-GRI-3)

OBJECTIVE: Determine the magnitude and method of chlorinated hydrocarbon insecticides in soils and to evaluate the influence of soil properties, temperature, humidity, and soil-water content on movement, particularly vapor-phase movement, and volatilization losses into the atmosphere.

APPROACH: Laboratory experiments will be conducted to ascertain the physical and chemical properties of chlorinated hydrocarbon insecticides and other pesticide materials, and evaluate the influence of various soil factors affecting their interactions with soils and waters. Commonly used pesticides will be applied under controlled conditions to semiarid soils. Predictions will be developed from measuring movement, volatilization losses, magnitude of absorption and breakdown products under controlled environmental conditions. Movement, redistribution, and volatilization of pesticides will be evaluated under actual field conditions to verify these predictions.

PROGRESS: Relationship between soil properties and vapor density of soil applied dieldrin indicated that vapor densities were inversely related to the soil organic matter content, both in wet and dry soils. Ten ppm dieldrin was required to produce a saturated vapor in a soil containing 67% clay. This indicates that clay plays only a minor role in absorption of such weakly polar compounds when sufficient water is present to cover the mineral surface. Vapor-phase desorption isotherms relating soil lindane concentration to relative vapor density were similar to isotherms relating soil lindane concentration to the solution concentration. Dieldrin volatilization was not affected by fluctuating the pressure of the gas flowing over the soil surface. Volatilization rate over a 29-day period indicated that rate of loss was initially dependent on vapor density at the soil surface but rapidly became a diffusion controlled process. Soil samples taken at various depths in plots treated with dieldrin and lindane indicated that lindane moved and disappeared from the soil much more rapidly than dieldrin. Concentration gradients at the surface of irrigated plots indicated that dieldrin and lindane were lost by volatilization from the surface. Lindane was probably also lost by decomposition.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0022, BEHAVIOR OF POLLUTANTS IN WATER

R.L. WERSHAW, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

The objective is to study pesticide residence time, transport mechanisms, and projected residue levels in natural soil and in natural hydrologic environments. The mechanisms of infiltration and solution of certain pesticides are being studied in the laboratory and conjunctive field studies are being planned to obtain information on the parameters related to subsurface infiltration and to the migration, retention, and decomposition in ground and surface waters.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

1.0023, PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS

K.G. DOXTADER, Colorado State University, Agricultural Experiment Sta., *Fort Collins, Colorado* 80521 (COL00242)

OBJECTIVE: Identify the principal degradation products and determine the mechanisms and kinetics of pesticide transformations in soil-water systems.

APPROACH: Pesticides will be incubated with soils of varying chemical, physical, and mineralogical composition. Studies will be made of the influence of temperature, light, aeration, added organic matter, and moisture on pesticide decomposition in these soils. Degradation will also be followed in soil-water suspensions and in columns of soils perfused with pesticide solution. Efforts will be made to determine the kinetics of herbicide decomposition and to identify and characterize major degradation products as well as to isolate the microorganisms responsible for the degradation process. Initial emphasis will be placed on studying the degradation of three herbicides: 2,4- dichlorophenoxyacetic acid (2,4-D), 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), and picloram (Tordon).

PROGRESS: Rates of decomposition of the herbicides pyrazon and diuron were measured in three different soils. Diuron was found to be extremely persistent in these soils; only very slight degradation was observed over an incubation period of 35 weeks. Significant pyrazon decomposition occurred in these same soils in less than one month. Evidence was obtained which indicated that microorganisms play a major role in the decomposition of pyrazon. In a sterilized soil, the concentration of the herbicide remained nearly constant over a period of several weeks. With the same soil under non-sterile conditions, appreciable pyrazon decomposition was observed. Four different bacterial types isolated from soil by an elective culture technique were found to be capable of degrading the herbicide in pure culture.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0024, CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION

F.G. VIETS, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Fort Collins, Colorado* 87101 (SWC-024-DFC-6)

OBJECTIVE: Determine the effects of soil type, temperature, organic matter, pH, aeration, and water content on the persistence, absorption, and movement of chlorinated pesticides in the soil-water system and on plant growth for the development of better systems of soil and water management and decontamination for the Northern Plains.

APPROACH: Chlorinated pesticides are added to natural and amended soils, clay minerals, and soil organic fractions with variables of pH, water content and movement, oxygen supply and other conditions and the absorption, rate of loss, degradation products, and movement under leaching conditions measured by chemical techniques. Mechanisms and rates of volatilization and effects on soil metabolism are measured. Soil and water samples from experimentally treated plots, watersheds and fields are analyzed for accumulation and rates of loss of pesticides.

PROGRESS: Evidence obtained to support earlier findings that adsorption of DDT is strongly influenced by positively charged particles. DDT which remained in the aqueous phase of sedimented soil- DDT systems was directly proportional to the amount of soluble and colloidal soil organic matter which resulted from sedimented soil. Various phenolic compounds which are water-soluble components of soil organic matter, significantly increased solution phase DDT when concentrations 0 1 mug of the phenolic compounds per ml. of water existed. Under aerobic conditions in a lab. study, rate of DDT conversion to DDE was greater at 50 C. than at 30 C. Soluble iron addition had no effect. After 140 days, the amount of DDE resulting from DDT degradation was 7.5 times greater at 50 C. than at 30 C. DDT was converted to DDD in anaerobic soil (submerged). Iron addition had no effect on the conversion process. After 10 days, about half the DDT was degraded at 30 C. and about 90% of DDT was degraded at 50 C. In a field study, no effect of soil mixing or added alfalfa observed in disappearance of dieldrin, endrin, DDD, and DDT from the top 8 cm. of soil during 22 weeks of treatment. Under same conditions, concentration of lindane and heptachlor decreased with time, and more pesticide was lost from soil receiving mixing treatment than from nonmixed soil.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0025, CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES

E.M. RAHN, Univ. of Delaware, Agricultural Experiment Sta., *Newark, Delaware* 19711 (DEL00011-H)

OBJECTIVE: Evaluate herbicide combinations for control of nutgrass in corn, tomatoes, peppers, and lima beans. Evaluate herbicide combinations on soybeans, and cucurbits to widen spectrum of weed control, to increase margin of crop safety, and to reduce herbicide residues. Evaluate long term effects of terbacil on asparagus. Study mode-of-action and basis-of-selectivity of alachlor and possibly other new herbicides. Monitor excessive persistence of herbicide residues, contamination of surface and ground water by herbicides, and reduction of nodulation leguminous crops by herbicides.

APPROACH: Combinations of herbicides at varying rates will be used on several crops on soil heavily infested with nutgrass. Combinations of herbicides at varying rates will be used on several crops on soil infested with, or seeded to, such persistent weeds as jimsonweed, velvet-leaf, ragweed, and morningglory. In mode-of-action studies, entrance of alachlor into root and shoot, as well as translocation and accumulation will be studied using gas chromatography and tritium labeled alachlor. Effect on respiration, protein synthesis using tritium labeled leucine, RNA synthesis using tritium labeled uradine will also be studied.

PROGRESS: Control of northern nutgrass in several vegetable crops was evaluated using two new herbicides, alachlor and butylate. On potatoes, alachlor, 4 lb/A, was as effective as the standard EPTC, 6 lb/A. On tomatoes and peppers, alachlor, 4 lb/A was effective on nutgrass but did injure the plants somewhat, but without yield reduction. Butylate caused crop injury. On sweet corn, alachlor, 2 lb/A, and butylate, 3 lb/A, both controlled nutgrass but butylate caused some yield reduction. On lima beans, alachlor, 2 lb/A, caused some early crop injury but did not reduce yields. In mode-of-action studies, alachlor, 1 ppm, did not inhibit uptake of H-leucine by oat coleoptiles, but did cause 65% inhibition of incorporation of H-leucine into protein and 50% reduction of respiration. Terbacil, 3/4 lb/A, provided full season weed control on established asparagus without affecting yield.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0026, ECONOMIC EFFECTS OF PESTICIDES AND OTHER WASTES ON NATURAL RESOURCE QUALITY

J. BINIEK, U.S. Dept. of Agriculture, Natural Resource Econ. Div., *Washington, District of Columbia* 20250 (NRE)

OBJECTIVE: Develop economic information and techniques of analysis for determining national compromises between production efficiency and adverse monetary and non-monetary effects arising from deterioration of resources quality.

APPROACH: Formal and informal cooperative relations are established with other research and action agencies to exchange information and data. Physical and economic research and information is reviewed and analyzed to determine the severity of specific pollution problems. Conceptual and qualitative studies are undertaken to improve analytical techniques for appraisal of adverse impact situations. Alternative pollution control systems are analyzed with the intent of selecting an optimum control system for policy decisions. Initial attention is given to adverse effects from chemical pesticides and animal waste.

PROGRESS: Preliminary investigations of animal waste and sedimentation problems were continued. A paper was presented at the Cornell Agricultural Waste Management Conference, January 10-13, 1969. The paper stressed the role of economics in merging the alleged conflicting goals of environmental quality and production efficiency. Contribution was also made to a paper presented at the Seminar 'Modifying the Soil and Water Environment for Approaching the Agricultural Potential of the Great Plains,' March 17-19, 1969 at Kansas State University. The paper identifies changes in livestock numbers, feedlot size and erosion as emerging problems of environmental quality.

SUPPORTED BY U.S. Dept. of Agriculture - E.R.S.

1.0027, NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA

C.C. HORTENSTINE, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-SL-01468)

OBJECTIVE: Determine the contribution of fertilizers, pesticides, and soil management practices to eutrophication in Lake Apopka. Also, to study the hydrologic pathways in the Lake Apopka watershed as a basis for using the mineral soils as a disposal area for sewage and citrus processing plant effluent.

APPROACH: Field plots will be established on newly cleared and on older cultivated muckland, fertilized with varying rates of mineral fertilizers, and cropped to appropriate vegetable plants. Plant tissue, soil, and soil solution samples from several soil depths will be analyzed periodically for plant nutrients. The movement of plant nutrients through sandy soils into ground water under selected orange groves will be studied by weekly sampling and analyses of soil and soil solution. The ability of these soils to retain applied phosphorus will be determined. Flow patterns of water through the lake will be determined through the use of fluorescein dye.

PROGRESS: Plots were laid out, fertilized differentially, and planted to spinach on organic soil which has been under cultivation for several years; plots were also laid out on newly drained area and planted to carrots with no fertilization. Soil in the first category had pH 6.15 and contained 1440 ppm Ca, 1990 ppm Mg, 39 ppm P, and 530 ppm K. Soil from the newly drained area had pH 7.0 and contained 2195 ppm Ca, 3565 ppm Mg, 356 ppm P, and 755 ppm K. Nutrients were extracted with 1N NH(4)OAc at pH 4.8. The high pH and high fertility in the latter case indicate that this is probably burned over area. Soil samples, from another section in the same area where the clearing operation is not completed, were collected for comparison to verify this assumption. These samples have not been analyzed. Soil moisture tubes were installed in both experimental areas, but no analytical data are available. The main objective in the current research is to determine the movement of N and P through the organic soil into surface water from previously cultivated and newly cultivated areas. Much of the eutrophication in Lake Apopka is attributed to farming on organic soils along the lake's shore. There are no valid research data to verify this assumption. Data collected under this project will partially serve to prove or disprove the accusation.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0028, MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS

R.S. MANSELL, Univ. of Florida, School of Agriculture, *Gainesville, Florida* 32601

The objective is to determine the influence of soil and carrier solution properties on adsorption, dispersion coefficient and rate of movement of pesticides, detergent surfactants, hydrophobic surfactants and tritiated water in sterilized soil columns at various degrees of saturation and flux.

Soils sterilized by gamma radiation will be set up in columns (10 cm cube, sides enclosed with acrylic plastic) for miscible displacement of tritiated water and radioisotope-tagged pesticides and surfactants. Inflow and outflow will be through porous fritted-glass plates in contact with the top and bottom of soil columns. Filtered gas, under variable pressure, will be admitted through the sides of the container to establish the desired degrees of unsaturation. A Sigmamotor pump will control flux of solutions having different surface tensions.

A flow cell in connection with a three-channel analyzer for beta spectrometry will form a liquid radiochromatography system for the nondestructive detection, analysis and recording of the radioactive chemicals eluting from the soil column.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0029, NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA

R.B. FORBES, Central Fla. Agric. Expt. Sta., *Sanford, Florida* 32771 (FLA-CF-01468)

OBJECTIVE: Determine the effects of pesticides, fertilizers, crops, water management and climate on the inputs and outgo of nutrients and pesticides from the soils in the Lake Apopka area; the hydrologic pathways through Lake Apopka in relation to the nutrient status of the lake; the effects of using the mineral soils of the area for disposal of wastes for abating pollution of surface water.

APPROACH: Field experiments on the muckland adjacent to Lake Apopka for study of effects of cropping, fertilization and water management systems; water sampling sites in mineral soils around lake to determine flow patterns and chemical quality; tracer studies of flow patterns in Lake Apopka; field plot studies in use of sewage plant effluent for irrigation of sandy soils.

PROGRESS: Water quality work formerly reported as non-projected has been expanded and written into a cooperative project with Soils and Agricultural Engineering Departments of the main station. Field experiments to determine the effects of fertilization and management programs on chemical properties of farm drainage water were begun in the latter part of 1969. Sampling of water in the canals and lake has continued. Little or no DDT has been found in drainage water since June 1968. Higher levels of soluble salts, solids and nutrients in the canals were found over the summer months than during the winter and spring.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0030, THE DISPOSITION OF PESTICIDES IN THE SOIL

J.E. GIDDENS, Univ. of Georgia, Agricultural Experiment Sta., *Athens, Georgia* 30601 (GEO00382)

OBJECTIVE: Determine the distribution of pesticides in selected soils and their drainage waters using sites to which known amounts of pesticides have been applied. Determine the physical, chemical and biological processes, and soil characteristics which are important in the disposition of pesticides in soils.

APPROACH: By soil perfusion and other techniques, breakdown rate of herbicides as influenced by soil properties and enriched microorganisms will be determined. Herbicidal effect upon rhizosphere organisms and effect of rhizosphere organism on herbicides will be determined. Specific root infecting fungi will be inoculated into the root zone in presence and absence of herbicides and their behaviour studied. Herbicidal effects upon soil processes as nitrification, N- fixation, and S-transformations will be studied.

PROGRESS: Trifluralin volatilization rate was high from moist soils but low from dry soils. Application of water to soil at different bars indicated high trifluralin loss from soil when moisture approached field capacity. Moisture application prior to trifluralin application resulted in greater herbicides volatilization than when herbicide was applied to dry soil then wetted. Further work continued to show the mitotic effect of trifluralin on plants but no effect on oxidative phosphorylations.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0031, DISPOSITION OF PESTICIDES IN THE SOIL

R.M. HARRISON, Georgia Agric. Expt. Sta., *Griffin, Georgia* 30212 (GEO00195)

OBJECTIVE: Determine the distribution of pesticides in selected soils and their drainage waters, using sites to which known amounts of pesticides have been applied. Determine the physical, chemical; and biological processes, and soil characteristics which are important in the disposition of pesticides in soils.

APPROACH: The distribution of selected pesticides will be determined by applying them to small, level, fallow, plots located on undisturbed profiles of differing soils of the Georgia Piedmont. Plots will be enclosed to retain rain which falls on a given plot and to prevent pesticide movement from plot to plot. At intervals, the profiles will be sampled to as much as five feet. Studies will later be extended to cropped soils. The pesticidal effect on mineralization and nitrification in unfertilized samples and in samples fertilized with an ammoniacal source, will be studied in the laboratory.

PROGRESS: Soil samples taken from a two year field study previously described have been analyzed by gas chromatography for trifluralin, aldrin, and endrin. No downward profile movement of the three pesticides below a 6 inch depth was found in the well drained Cecil soil site and the imperfectly drained Iradell soil. Trifluralin was previously shown to be absent after 10 months. Over 50 percent of aldrin and endrin remained in the soil over the two year period. A major portion of aldrin was degraded into dieldrin and endrin was partially altered into a compound not identified. Additional research has not been undertaken as the project has been terminated. A technical paper on the soil extraction of trifluralin is being reviewed for publication and a second paper on the field research is presently being written.

1. PESTICIDE RESIDUES AND AQUATIC ENVIRONMENTS

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0032, PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST

M.J. LEWALLEN, U.S. Dept. of Agriculture, Agricultural Engineering Div, *Watkinsville, Georgia* 30677 (901-032-B606)

OBJECTIVE: Develop methods for excluding or removing pesticide pollutants from farmstead water supply systems.

APPROACH: Studies will be made of pesticide pollution of farmstead domestic water supplies and to identify sources and routes of contamination. The relation of susceptibility of water supplies to pesticide contamination with susceptibility to other contaminants such as bacteria or nitrate will be determined. Studies will be made of well construction techniques to determine level of protection needed to eliminate pesticide contamination. Determination will be made of the performance of pesticide removal equipment, devices and techniques to effect a safe economical water supply. Investigations will be conducted to outline the requirements for a disposal system for waste water collected from the cleaning of application equipment or from the disposal of excess persistent pesticides.

PROGRESS: Continued investigation of a shallow, bored well contaminated from a non-leached source with DDT and Toxaphene shows little change in contamination level after 3 years' observation. Pesticide level in the water remains stable (DDT less than ppb, Toxaphene few ppb) while levels in well sediment remain in the high ppm range. Level of contaminants in soil surrounding the well is generally lower than was the level during the previous year. Soil samples taken in increments of 4 inches indicate levels of several ppm in the surface 4 inches while only low ppb levels are found below 4 inches. Two commercially available charcoal filters were dependent on the flow rate when evaluated for the removal of lindane (low ppm range) from water. Removal efficiency varied from approximately 75 percent at 1 GPM to approximately 30 percent at 5 GPM. Water from 27 local wells was sampled for bacterial contamination and nitrate level. Approximately 30 percent exceeded the permissible nitrate level of 10 ppm NO(3)-N. Maximum NO(3)-N measured nearly 50 ppm.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - A.D.P

1.0033, PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT

A.W. WHITE, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Watkinsville, Georgia* 30677 (SWC-024-BAW-03)

OBJECTIVE: Determine the important pathways of pesticide loss from soils and waters, including the magnitude of losses by runoff and erosion, volatilization, and decomposition; determine the mechanisms involved and conditions that influence pesticide persistence and losses from soils and waters; and develop methods and field practices for minimizing the polluting effects of pesticides on soil and water resources.

APPROACH: The extent and mechanism of pesticide losses from soils and waters by various pathways will be determined in field and laboratory experiments. Movement of pesticides over and through the soil will be evaluated under natural and artificial rainfall conditions. Environmental conditions and soil factors that influence persistence and loss of pesticides from soils and waters will be determined. The effect of management systems on soil and water quality will be evaluated and new systems will be developed for minimizing the polluting effects of pesticides on soil and water quality.

PROGRESS: Results from 96-day oven incubation studies showed that the chlorinated insecticides lindane and dieldrin disappeared from Cecil soil at appreciable rates under warm dry conditions. The half-life values for 0.5 to 5.0 ppm lindane in dry Cecil sandy loam at 45 and 65 were 50 and 13 days, respectively. Under the same conditions dieldrin was approximately ten times more persistent than lindane. The observed disappearances followed first- and second-order rates, and equations were derived for estimating lindane and dieldrin persistence in soil with time at 45 and 65 . At room temperature no loss of either pesticide was measured. It appears that a significant part of the lindane and dieldrin disappearance in warm dry soils observed in these experiments may be due to catalytic degradation. Significant degradation was found at 45 and 65 in the case of lindane as evidenced by the appearance of pentachlorocyclohexene, a reported lindane degradation product. Further evidence of lindane degradation was indicated by the release of significant levels of chlorides in warm dry soils and clays. Degradation was retarded by small amounts of moisture and by organic matter, and was enhanced by the presence of free ion oxides.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0034, PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS

R.E. GREEN, Univ. of Hawaii, Agricultural Experiment Sta., *Honolulu, Hawaii* 96822 (HAW00141)

OBJECTIVE: Identify and characte[illegible] physical-chemical properties of the pesticide-soil-water system; develop mathematical model(s) which will provide semi-quantitative prediction of pesticide movement in soil-water systems; measure pesticide transport through and over soil in the field or in lysimeters.

APPROACH: The kinetics of adsorption-desorption reactions of carboxylic acid herbicides will be studied using selected soils; a mathematical model will be developed which will describe the effects of pesticide adsorption, degradation and hydrodynamic dispersion using available input data; movement of picloram with infiltrating water will be studied under field conditions on the Molokai soil.

PROGRESS: (1) Adsorption isotherms for four s-triazine herbicides which are important to Hawaiian agriculture were measured on four soils having a wide range of organic matter contents and different mineralogies. The relative magnitudes of adsorption were nearly the same on all soils: ametryne, sumatol (GS-14254), atrazine, simazine. Soil acidity and O.M. content are both positively related to triazine adsorption. (2) A procedure was developed to allow determination of the distribution of triazines between adsorbed and solution phases as hydrolysis proceeded. Distribution coefficients for atrazine increased several fold during a 60-day period; this implies decreased mobility of the residual parent compound. (3) An adsorption method, consisting of continuous flow equilibration of soil with a pesticide solution followed by sebsequent displacement with an appropriate organic solvent was developed and tested with two herbicides (atrazine and diuron) on four soils. This method provided high precision on all adsorbents, avoided destruction of aggregates, and was useful in measuring adsorption reversibility.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0035, HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL

R.E. GREEN, Univ. of Hawaii, Agricultural Experiment Sta., *Honolulu, Hawaii* 96822 (HAW00127)

OBJECTIVE: Relate the adsorption and desorption of organic herbicides to the chemical and physical properties of Hawaiian soil. Determine the importance of microbial degradation of herbicides. Determine the effect of soil pore-size distribution and associated soil- water relations on herbicides equilibria in soils and absorption by plant roots.

APPROACH: Adsorption will be characterized by measurement of herbicide adsorption on soils or soil separates from aqueous solution of the herbicide. An attempt will be made to identify the 'active' fraction of the organic matter or the clay-organic complex and to measure the partition coefficient of this fraction. In the field, particular attention will be given to the longevity of weed control in sugarcane at various rates of s-triazine herbicides. In the laboratory, C tagged herbicides (primarily s-triazine compounds) will be used to study (a) gross degradation of herbicides, and the nature of degradation deaminization, in relation to the availability of energy sources (including plant roots) and water.

PROGRESS: Laboratory studies were continued on the degradation of atrazine, simazine, ametryne, and GS-14254 on Kapaa, Molokai, Lualualei, and Kaipoioi soils. The influence of temperature, adsorption, pH, organic carbon (charcoal), moisture levels, and soil types were evaluated. Also, the role of molecular structure on degradation was studied. Degradation of atrazine followed the first order kinetics in two soils used (Kapaa 0 Lualualei) at 24, 30, and 50 C; only negligible loss was observed at 10 C. Decrease in pH (pH 8.0, 7.0, 4.5, 3.5, field pH) increased degradation, but this pH effect differed among soils (Kapaa 0 Kaipoioi 0 Molokai 0 Lualualei) which could be accounted for by soil organic matter and clay contents that are essential for increased adsorption and consequent hydrolysis. There is clear evidence that increased adsorption (by increasing the amount of soil to a uniform amount of herbicide solution) results to higher degradation of the triazines in soils (Kapaa 0 Lualualei), but this phenomenon is also limited by pH levels (higher degradation at pH 3.5 than at pH 8.0). Moisture levels haste atrazine degradation in Kapaa soil.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0036, POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII

L.S. LAU, Univ. of Hawaii, Water Resources Research Ctr., *Honolulu, Hawaii* 96822

Determination of the absorptive and adsorptive capacities of Hawaii soils and fractured rocks with respect to certain potential pollutants of the underlying basal ground water bodies, including sewage constituents and selected pesticides that are applied through agricultural uses. Determination of quantitative and qualitative effects of recharge of the basal ground water by nonpotable waters, including quantity and head increases, flow pattern and dispersion, fate and travel of pollutants after reaching the ground water bodies.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0037, REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT

W.N. BRUCE, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-12-0317)

OBJECTIVE: Determine physical, biochemical, and biological factors influencing occurrence and persistence of insecticidal chemical residues in soils and agricultural commodities. Identify fundamental factors influencing magnitude of air and water pollution by insecticidal chemical residues. Develop basic studies related to the metabolism and detoxication of insecticidal chemical residues in animals, plants, soils and water. Identify effects of residues on ecosystems with emphasis on fish and wildlife. Influence of residues on soil microflora, microfauna, and non-insect fauna. Develop analytical techniques.

APPROACH: Study persistence, metabolism and detoxication of insecticide chemical residues in soils, plants, animals and water and study the effects of toxicant residues on ecosystems in soils and water.

PROGRESS: Methoxychlor, dieldrin, and furadan residues in the soil as they relate to the contamination of the aquatic environment are under investigation. Soil, pond silt, water, algae, and fish samples have been analyzed at weekly and monthly intervals following treatment of a watershed with these chemicals. Four days after a treatment with furadan at a rate of 4 lb. per acre and one day after a one inch rainfall, furadan was found in the pond water (.0167 ppm), plankton (2.957 to 4.839 ppm) and suspended silt and organic matter in one liter of water (2.465 to 3.873 micrograms). The analysis of all the fish and water samples has not been completed. Of special interest in the field experiment was the lack of reproduction in the Fairfield pond where dieldrin residues in fish ovaries and eggs were between 0.5 and 1.0 ppm. The water solubility of methoxychlor is higher than that of DDT. The reaction velocity of dehydrochlorination of methoxychlor (methoxychlor yields methoxy-DDE) is slower than that of DDT (DDT yields DDE) in water. Most of the methoxychlor, as with DDT, is adsorbed on sediment and silt in the water. However, significant amounts of methoxy-DDE were found in the water. Trace amounts of O,P - DDT are found in DDT-treated waters, but O,P - methoxychlor - DDE was not detected in methoxychlor- treated waters. Pond water and distilled water gave similar results.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0038, ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE

W.N. BRUCE, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-12-0323)

OBJECTIVE: Devise and improve sampling, extraction, and analytical techniques to facilitate quantitation of pesticide residues and degradation products in soils, plants, and animals. Conduct a regional study of the interaction of organophosphate insecticides and triazine herbicides employed for control of corn pests. Examine the action, persistence, degradation and translocation of selected biocides and their metabolites in plants, animals, and microorganisms. Describe and evaluate biocide cycling through the soil and water environments, particularly in reference to food chains.

APPROACH: Devise and improve sampling, extraction, and analytical techniques to facilitate quantitation of pesticide residues and degradation products in soils, plants, and animals. Conduct a regional study of the interactions of organophosphate insecticides and triazine herbicides employed for control of corn pests. Examine the action, persistence, degradation, and translocation of selected biocides and their metabolites in plants, animals, and microorganisms. Describe and evaluate biocide cycling through the soil and water environments, particularly in reference to food chains.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0039, PATTERNS OF PESTICIDE CONTAMINATION OF WATER

L. CHANDLER, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01480)

OBJECTIVE: Determine interrelationships of pesticides and soils with respect to water transport and/or deposition. Analyze the biotic significances of earthworms and stoneflies in multidimensional quantitative systems.

APPROACH: Class-representative insecticides will be applied at several concentrations to columns of soils. Water will be percolated through each and analyzed by gas liquid chromatography. Columns will be analyzed to determine depositions. Large-scale simulation will be conducted to establish significance of lateral movements. Baseline data will be obtained by studies of stoneflies and earthworms at stream and floodplain sites and in the laboratory. Methods of quantitative ecological analyses will be developed.

PROGRESS: Species of winter stoneflies (Allocapnia spp.) were studied to determine: the factors related to coexistence; the basic life histories of our common species; the value of species as ecological indicators of stream conditions; and the major mortality factors. Preliminary results were obtained for all objectives as follows: competition among species is reduced by differences in seasonal development of the immatures and/or substrate preferences; development from eclosion to emergence is extremely rapid, the greatest period of time being spent in the egg stage (8-11 months); species are good indicators of certain specific factors but should not be used in the generalized sense of indicators; and silting and catastrophic flooding are the two most important mortality factors. Population predictions can be made on the basis of current speed as related to gravel-sand substrate.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0040, REDUCTION OF PESTICIDE RESIDUE HAZARDS

J. FAHEY, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01533)

OBJECTIVE: Determine the fundamental physical, biochemical, and biological factors influencing occurrence, magnitude, interaction, and persistence of insecticidal chemical residues in soils, water air and raw agricultural commodities.

APPROACH: The effect of cultural practices on distribution and persistence of residues will be studied. This will include the effects of environmental factors such as temperature, relative humidity, and pH. The mechanism of translocation will be determined in greenhouse tests or growth chambers.

PROGRESS: Investigations of Gardona & Azodrin were conducted to determine practicality of using these chemicals to control insect pests to develop data that could be used to obtain tolerances and labels for their use. At recommended dosages the Gardona residues on raw vegetables and fruit varied from 1.2 to 19 ppm. Canning process removed from 97 to 100% of Gardona residues from vegetables, pears and peaches. Except with cherries, the Gardona residue found in canned fruit and vegetables was less than 0.1 ppm. Canned cherries contained 0.2 to 0.8 ppm of Gardona. In the study of Azodrin residues in green beans and tomatoes, 1.6 to 7.3 ppm of Azodrin on raw vegetables and .1 to .3 ppm of Azodrin was in canned products. Methods for the study of DDT residues in mint hay and mint oil were developed. Samples of mint hay analyzed for phygon residues contained less than 0.1 ppm. 0.05 to 0.1 ppm of chlorinated hydrocarbon residues in swine permitted to forage in corn stover or soil that had been treated for corn root pests. Methods for study of Gardona and Ronnel residues in manure were developed.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0041, EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANO-TOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES

E.J. MONKE, Purdue University, School of Agriculture, *Lafayette, Indiana* 47907

Laboratory experiments will be utilized to study sorption mechanisms of the organo-toxicant materials to mineral and organic fractions in the soil and the movement of these substances through soil profiles. Incubation studies using enrichment culture techniques will be used to isolate microorganisms capable of decomposing those materials which offer the greatest water pollution hazards. Special studies will be made to determine relationships between molecular structure and decomposability of specific toxic substances to determine the feasibility of altering molecular structures. The feasibility of treating reservoirs with special adsorbing or chelating materials in order to flocculate, precipitate, or otherwise deactivate the organo- toxicant materials or their residual decomposition products will be studied using radiological tracer techniques with model filters. Accompanying biological experiments with similar organotoxicant materials will be conducted in laboratory aquaria to determine the effects of different concentrations and synergisms.

Field studies will be conducted on well characterized, controlled watersheds and associated reservoirs to determine the effects of application practices on pollution hazards. The rate of the applied organo-toxicant materials both on the watershed and subsequently in the small reservoir will be determined possibly using radioisotope tracer techniques. Attention will be given to the development of ready means of detecting the toxic substances or its residue in water storages. Both aquatic and terrestrial indicator organisms will be used to assess the movement and concentration of the organo-toxicant, soil-borne organo toxicant, or organo-toxicant residue on the watershed and in associated small reservoirs. Samples of water, bottom muds and watershed soils will be subjected to chemical, biological and physical analyses during pretreatment, treatment, and post-treatment periods for possible organo-toxicant residue and pertinent fauna.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0042, CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS

J.L. WHITE, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01224)

OBJECTIVE: Characterize the surfaces of colloidal crystalline and amorphous soil materials.

APPROACH: Infrared and x-ray diffraction techniques will be used to identify crystalline colloids and relate surface properties to structure and chemical composition. The presence, extent and nature of the reactive surfaces of amorphous colloids will be studied by infrared measurements of water and ammonia absorption, and measurement of rate of fluoride complexation of reactive aluminum at surfaces with a fluoride specific ion electrode.

PROGRESS: Infrared studies of hydrogen bonding in clay-adsorbed water in hydronium-saturated micaceous clays have revealed stronger hydrogen bonding; infrared OH stretching frequencies of 1940 cm---1, corresponding to 0-0 distances of 2.47 A., have been observed. Similarities between properties of clay-adsorbed water and those of polywater have been described. Observations provide a better basis for understanding mechanism of bonding of pesticides to soil surfaces as well as the origin of 'surface acidity' which strongly affects the adsorption and degradation of pesticides. A computer library of crystal structure programs for x-ray diffraction analysis of cation positions and water structure in the interlayer region of vermiculite has been developed. Degradation of 12 s-triazine herbicides by montmorillonitic soil clays under natural conditions has been demonstrated by infrared spectroscopy. Highly acidic environment of the clay surface was shown to cause degradation by protonation and chemical hydrolysis. The degraded herbicide is held tightly by the soil colloid so that it is unlikely to enter the ground water to any significant extent.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0043, INSECTICIDAL CHEMICALS IN THE ENVIRONMENT

P.A. DAHM, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01686)

OBJECTIVE: Determine the fundamental physical, biochemical, and biological factors influencing occurrence, magnitude, interaction, and persistence of insecticidal chemical residues in soils and raw agricultural commodities. Develop basic studies related to the metabolism and detoxication of insecticidal chemical residues in animals, plants, soils, and water. Seek methods of removing or reducing residues of insecticidal chemicals from the environment. Develop and improve analytical techniques essential to the pursuit of this research.

APPROACH: Greatest emphasis will be placed on objective 2, by studying the metabolism of organophosphorus, carbamate, and chlorinated hydrocarbon insecticides in animals, plants, soils, and water. Differences between closely and distantly related species of animals and plants will be investigated as well as intraspecific factors such as age, physiological conditions, and environmental influences. The interaction of insecticides with other synthetic chemicals in our environment will also be explored.

PROGRESS: Two nitrogen-fixing soil microorganisms, Rhizobium japonicum and R. meliloti, were incubated with parathion in a phosphate buffer. Time course studies showed that parathion was rapidly metabolized in about 25 hours. Gas-liquid chromatography, thin-layer chromatography, and colorimetric analyses showed that reduction of parathion to aminoparathion was the major metabolic pathway. Aqueous fractions of S-parathion provided evidence that parathion was also being metabolized to 0,0-diethyl phosphorothioic acid. An oxidative enzyme system was evidently lacking since no paraoxon was found.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1B. SURFACE WATERS

1.0044, MOVEMENT OF HERBICIDES IN SOIL BY MASS FLOW

H.P. JOHNSON, Iowa State University, School of Engineering, *Ames, Iowa* 50010

The research will define what factors are dominant in the movement of herbicides by mass flow.

The primary objectives of the proposed research are (1) to define the factors that are dominant in the movement of selected herbicides in soil by mass flow under unsaturated conditions, (2) to determine whether mass flow is the major process by which selected classes of herbicides move in the soil, (3) to develop a mathematical model to describe the movement of herbicides in soil by mass flow, for the boundary and initial conditions used in the experiment, (4) to investigate the possibility of regulating the movement of herbicides by manipulating the soil variables that affect movement by mass flow.

The variables, soil moisture and temperature, soil type, soil structure and the chemical properties of the herbicide will be studied in mass flow experiments under unsaturated conditions. The research proposed in this study will give scientists and engineers a better understanding of herbicide movement in soils and may be of value in controlling some of the factors responsible for herbicide residues.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0045, PROPERTIES OF TILE DRAINAGE WATER

T.L. WILLRICH, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01655)

Progress: Grab samples were collected only twice from the outlets of ten tile drainage systems during the spring and summer months because precipitation amounts and frequency of occurrences were not sufficient to cause tile flow except for short time intervals. The samples were analyzed for total nitrogen, phosphorus, potassium, total hardness, total alkalinity, sulfate and chlorinated hydrocarbon residual concentrations in addition to temperature, pH and specific conductance. Because of the limited number of samplings, quantitative values obtained during this year will be reported in the terminal report along with values obtained during the previous three years of investigation.

SUPPORTED BY Iowa State Government - Des Moines

1.0046, REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT

T.L. HOPKINS, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN00481)

OBJECTIVE: Determine fundamental physical, biochemical, and biological factors influencing occurrence, magnitude, interaction, and persistence of insecticidal chemical residues in soils and raw agricultural commodities; evaluate factors influencing the magnitude and mechanism of air and water pollution; develop studies related to the metabolism and detoxication of insecticidal chemical residues in animals, plants, soils and water; evaluate effects of residues of insecticidal chemicals on ecosystems on fish and wildlife; develop analytical techniques.

APPROACH: Degradation and metabolism of organophosphorus insecticides studied with environmental effects of solar radiation, temperature, and humidity. Field studies are in progress.

PROGRESS: The disappearance and residues of several organic insecticides applied to soil and corn have been studied for the fourth consecutive year in the Cedar Bluff Irrigation District. Diazinon and parathion soil treatments disappeared rapidly but heptachlor, aldrin and their epoxides persisted in slowly decreasing amounts after soil application and small residues were detected from the 1967 treatments. Corn plant samples taken from plots treated with foliar sprays of diazinon, methyl parathion and endrin showed organophosphorus residues to be very low after one month and moderate endrin residues. Wild mice trapped in the area contained small dieldrin residues. Fish collected from various river sites showed only small DDE residues. A microcolumn cleanup method has been extended to include additional pesticides and modified to handle larger samples. Photodegradation studies with five organophosphorus insecticides applied to glass and leaf surfaces both under field and laboratory conditions reveal step-wise reactions of oxidation, isomerization and hydrolysis induced by various wavelengths of radiation.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0047, REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES

C.T. HAAN, Univ. of Kentucky, Agricultural Experiment Sta., *Lexington, Kentucky* 40506 (KY00114)

OBJECTIVE: Determine extent and state in which pesticides occur in farm water supplies; evaluate effectiveness of presently recommended farmstead treatment systems in removing pesticide residues; investigate possible application of new techniques and system arrangements to remove pesticide residues from rural water supplies.

APPROACH: Selected farm water supplies will be tested using standard chemical analysis techniques to ascertain the degree of pesticide contamination in these locations. Results will be correlated to the pesticide history of the watershed. The effectiveness of conventional rural water treatment and filtering methods in removing different pesticides will be studied. New or potential methods of removing pesticide residues from water supplies will be studied and evaluated for possible application on the farmstead.

PROGRESS: Twelve fallow plots 3.81 feet square were treated with Aldrin, Dieldrin, and DDT. After waiting for various periods of time (15 minutes, 1 day and 3 days), artificial rainfall was applied. The runoff water, eroded sediments, and soil remaining on the plots were then analyzed to determine the concentration of the three pesticides. At this time the data analysis is incomplete.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0048, INACTIVATION AND LOSS PESTICIDES FROM SOIL

R.E. PHILLIPS, Univ. of Kentucky, Agricultural Experiment Sta., *Lexington, Kentucky* 40506 (KY00202)

OBJECTIVE: Determine inactivation and loss of pesticides from soil by retention and release and movement of water through and over soil for the purpose of identifying primary loss processes, relating these processes to soil properties, and predicting pesticide persistence.

APPROACH: Both laboratory and field experiments will be conducted using selected herbicides. Laboratory experiments will include the measurement of diffusion coefficients of the selected herbicides in soil and/or pure clays and in bulk water, movement in soil columns by mass flow of water as influenced by soil water content, soil type, and pH, and adsorption isotherms. A field experiment will involve the application of four herbicides to each of four soil-surface conditions; fallow, corn, bluegrass sod, and killed bluegrass sod. Soil samples will be taken periodically with depth and analyzed for herbicide concentration; soil water content with depth will be monitored.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0049, ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS

H.T. BARR, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01408)

OBJECTIVE: Determine slope of land in connection with length of row for adequate drainage for various soils and crops grown in Louisiana.

APPROACH: Land will be graded to provide various gradients and lengths of rows. Crops will be planted and amounts of water flow will be measured at ends of fields. Work in cooperation with ARS Soil and Water Conservation Service, Line projects SWC 6-b2 and SWC 6-b1.

PROGRESS: LA-23: Row Length Versus Grade Study, LSU Ben Hur Farm, using 32 plots totaling 88 acres, where 4 grades and 4 row lengths are under study. Six years of data have been analyzed and a prediction equation for runoff is being developed. LA-28: Fate of Applied Pesticide Study, LSU Ben Hur Farm. Three years' data on the disposition of endrin applied to 12 plots have been analyzed with regard to persistence, degradation, volatilization and contamination of runoff. LA-29, LA-30: Drainage Requirements of Crops, LSU Ben Hur Farm. Three years' data from a study of sugarcane yield as affected by 4 water table depths and two flooding treatments are being analyzed. LA-34: Nitrogen- Sulfur Ratios in Sugar Cane, LSU Ben Hur Farm. The effect of various N/S ratios on sucrose production has been studied for three years. LA- 35: Irrigation of Sugarcane, LSU Ben Hur Farm. The effect of two irrigation methods on the yield of sugarcane is being studied.

SUPPORTED BY Louisiana State Government - Baton Rouge

1.0050, WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA

G.H. WILLIS, Louisiana State University, U.S.D.A. Soil & Wa. Cons. Div., *Baton Rouge, Louisiana* 70803 (SWC-024-BBR-3)

OBJECTIVE: Determine the mechanism for and extent of movement of pesticides, plant nutrients and other pollutants over and through the soil in drainage water and develop methods for alleviating the effects of pollutants on water and soil resources.

APPROACH: Extent and mechanism of movement of pollutants in surface and subsurface drainage water will be measured in the laboratory and on field plots. Measurement systems will be developed for enhancing chemical or biological degradation and immobilization, and disposal of the polluting materials in soil and water.

PROGRESS: Where endrin was applied to sugar cane for borer control on very dry Mhoon clay loam at Baton Rouge, Louisiana, the concentration in surface drainage water was 1.06 and 0.46 ppb when rain followed the application in 24 and 72 hours, respectively. Concentrations in tile effluent of 0.45 and 0.07 ppb from rains 24 to 72 hours after rain were attributed to the flow of water through cracks in the soil instead of by true percolation to the tile. Endrin found in the soil 6 months after application was 65 and 24 ppb, respectively, where rains came 24 and 72 hours after application. This difference probably was due to the loss by volatilization of the pesticide with the variation in exposure to temperature and other weather phenomena before rain fell. All these results confirm similar findings in 1967 and 1968, and suggest that pesticide content of soil and water will be lessened if the material is applied as long as possible before rain occurs. A method was developed at Baton Rouge, Louisiana for detecting losses by volatilization of pesticides applied to the soil. Preliminary results of studies underway indicate that flooding the soil retarded the volatilization of DDT and DDD, suggesting that this treatment might be used to reduce the atmospheric pollution potential of a pesticide-treated soil.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0051, CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND

E. EPSTEIN, Univ. of Maine, U.S.D.A. Soil & Wa. Cons. Div., *Orono, Maine* 04473 (SWC-024-AOR-3)

OBJECTIVE: Determine amounts of agricultural chemicals carried in runoff and erosion; determine persistence of agricultural chemicals and leaching losses under intensive cultivation.

APPROACH: Erosion plots at Presque Isle in continuous potatoes and in a 3 year rotation of potatoes, sugarbeets, and peas are treated with the fungicides, herbicides, and insecticides currently recommended by the Maine Agricultural Experiment Station. Runoff and sediment samples are collected and analyzed after each storm. Soil surface samples are obtained before and after each chemical applicaiton. Soil profile samples are collected and analyzed periodically.

PROGRESS: It is important to know the mechanism by which pesticides move from treated agricultural soils. A laboratory experiment was conducted in which Caribou and Marshall silt loams were treated with DDT, methoxychlor and endosulfan. These soils were then fractionated into selected particle size ranges and insecticide in each size range was determined. For both soils, the greatest concentrations were found in the clay fraction and within this fraction the highest concentrations were in the 0.08 to 0.5 Mu size. The lowest concentrations were found in sand fraction.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0052, PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST

E.R. JONES, U.S. Dept. of Agriculture, Agricultural Engin. Res. Div., *Beltsville, Maryland* 20705 (901-032-B605)

OBJECTIVE: Develop methods for preventing pesticide contamination of farmstead water supply systems.

APPROACH: Determine design characteristics for farmstead water well construction which will reduce the possibility of pesticide contamination. These studies will include investigations of selected cases of pesticide contamination to learn means of entry, concentration and persistence of contamination. Develop equipment and/or procedures to eliminate or reduce the risk of pesticides entering the system by backsiphonage or cross-connections. Develop methods and techniques for using, handling and storing of pesticides which will eliminate the threat of contamination of the water system. This will include studies of the pesticide equipment servicing area where filling, overflow, spillage, leakage, drainage and washing practices may influence the incidence of pesticide contamination.

PROGRESS: Sediment removed from the bottom of well WA10A contained dead insects, macerated straw, and a greasy substance. By error these were discarded. The sediment was allowed to settle for 48 hours and samples taken of sediment and supernate. The results of analysis were sediment dry weight 1000.0 ppb sulfur, 40.0 ppb DDT, supernate 0.05 ppb DDT. The concentration in the supernate was similar to a water sample obtained 42 days earlier, 0.04 ppb DDT. The ratio of DDT in sediment to supernate of 800:1 is similar to values for surface water. The affinity of free DDT in water for the air water interface and volatilization by codistillation make it quite certain that the major avenue for penetration of chlorinated hydrocarbons below the water table is inadequately protected wells. Concentrations found in contaminated well water are normally less than that reported for rain water. Research well WA10B was constructed 113 feet south of Washington County, Maryland sample well WA10A. The technique used, if further developed and adopted, may reduce the cost of the cased portion of the well 50%. Present costs encourage inadequate depth of casing and grouting. Well WA10B produces water of more uniform quality than well WA10A. Collecting samples after heavy rainfall in Wicomico County resulted in an increase of confirmed pesticide concentrations.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - A.D.P

1.0053, BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS

A.W. TAYLOR, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Beltsville, Maryland* 20705 (SWCW8-AB-7)

OBJECTIVE: Study factors affecting accumulation, movement, and persistence of pesticides and pollutants in soil and water and their uptake by plants.

APPROACH: Laboratory, greenhouse, and field experiments will be conducted on the chemistry and microbiology of chlorinated hydrocarbon insecticides, selected herbicides, and the heavy-metal pollutants in soils and water. Analytical methods will be developed for determining these compounds in soil, water, and plants. Greenhouse and field experiments will be conducted to evaluate the accumulation, movement, and persistence of selected chlorinated hydrocarbon insecticides and certain metal pollutants in soils and water and the accumulation of thess compounds in the plants.

PROGRESS: Three years' measurement of dieldrin concentrations in storm-runoff water from small agricultural watersheds show concentrations decrease steadily to about 30% of their initial values by the third year. No dieldrin was found in a stream draining the general area that contains the treated plots. Field studies on aerial movement of dieldrin indicate that volatilization is the main pathway by which dieldrin leaves the soil. Compounds derived from alfalfa distillates accelerated the anaerobic decomposition of DDT in soil. Studies show the adsorption of amitrole and prometone on montmorillonite and soil organic matter is dependent on the surface proton supply. Bromegrass takes up Cd more readily than Pb, or Zn. Plant uptake of Pb increases very slowly with increasing Pb content of the soil, but is sensitive to pH changes. Studies on phosphate and nitrate losses in water draining woodland and agricultural areas have been initiated. Preliminary data show small but measurable amounts from both sources.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0054, CONTROL OF PESTICIDES IN SOIL AND WATER

A.W. TAYLOR, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Beltsville, Maryland* 20705 (SWC-024-AB-3)

OBJECTIVE: Study factors affecting accumulation, movement and persistence of pesticides in soil and water and their accumulation by plants.

APPROACH: Laboratory greenhouse and field experiments are conducted on the chemistry and microbiology of chlorinated hydrocarbon insecticides and selected herbicides. Greenhouse and field experiments will be conducted to evaluate the accumulation, movement and persistence of selected chlorinated hydrocarbon insecticides in soil, air and water and their accumulation in plants. Laboratory experiments will be conducted on the chemistry of pesticides and herbicides in soil and water. Analytical procedures for the determination of these compounds will be developed where necessary.

PROGRESS: Field studies demonstrated that volatilization is the principal pathway by which dieldrin and heptachlor are lost from soil to the general environment. The concentrations of the insecticides in corn leaves exposed to the vapors are in the order of 1 ppm, while the concentrations in the kernels remains less than 0.02 ppm. The total amount of pesticide in the plant is about 1 gram per acre. Dieldrin remains stable on the leaves, but most of the heptachlor is degraded to heptachlor epoxide. Laboratory studies have confirmed the existence of natural compounds in green plant tissues that may be mistaken for dieldrin in routine chemical analyses. Procedures for overcoming the analytical difficulties when these compounds are present have been developed. Research on analytical methodology needed for the identification and determination of pesticides in the environment is continuing.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0055, PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS

K.H. DEUBERT, Univ. of Massachusetts, Agricultural Experiment Sta., ***Amherst, Massachusetts*** 01002 (MAS00251)

OBJECTIVE: Study of pesticides in relation to accumulation and persistence, movement to water, final destination and concentration of pesticide chemicals used on cranberry bogs.

APPROACH: Investigations on the chlorinated hydrocarbons, similar studies on organic phosphates. Soil samples at varying depths taken in cranberry bogs, ditches and reservoirs. Perennial vegetation, algae and water animals will be collected and analyzed.

PROGRESS: Work on this project had been interrupted for several months in consequence of personnel changes. The distribution of dieldrin and DDT (detected as p,p -DDT) in soil was closely studied using both gas-liquid-chromatography and thin-layer chromatography. Approximately 75% of dieldrin residues and 85-90% of DDT residues in the 1-4 inch layer of soil are present in the top two inches. Leaching experiments showed that over 0.4% of dieldrin residues in soil (containing 2.3 ppm of dieldrin) can be removed with water corresponding to 10 inches percolated through two inches of soil. Dieldrin and DDT residues in drainage ditches and canals were generally higher (0.4-0.7 ppm) than in 1965 (0.092 ppm). The field experiment with parathion reported last year was repeated. Amounts of residues detected in drainage water were slightly lower than the amounts detected the year before.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0056, TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS

K.H. DEUBERT, Univ. of Massachusetts, Agricultural Experiment Sta., ***Amherst, Massachusetts*** 01002 (MAS00293)

OBJECTIVE: Determine translocation of pesticides from cranberry bogs and relationship of organic matter.

APPROACH: Actual bog conditions will be studied and simulated in the laboratory. Interaction of pesticides and organic colloids will be determined. Determinations will be made of cation exchange capacity, pesticide residues, exchangeable bases and carbon content of soil.

PROGRESS: Monitoring studies on dieldrin and DDT in bog soil and drainage canals were continued. Most important result: ratio of translocation of DDT on a cranberry bog--2 ppm about 120 feet in 12 years. Correlection between pesticide residues and cation-exchange capacity, total exchangeable bases, exchangeable Ca , K , Na and base saturation are caused by the correlation between amounts of pesticide residues and organic matter in the soil. Pesticide residues (dieldrin and DDT) in flood water were about 10% above the residue levels in fresh water used for flooding. Copper of copper sulfate applied at a rate of 4 lbs./acre/foot water disappears from flood water from about 0.6 ppm Cu (double dosage) to 0.02 ppm Cu and less within 10 days.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0057, RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS

G.E. GUYER, Michigan State University, Graduate School, ***East Lansing, Michigan*** 48823

The movement, degradation, and concentration of pesticides in the soil ecosystem was investigated. Special attention was directed to the sorption phenomenon as it relates to clay minerals and organic matter. Selected pesticides were followed through the various trophic levels of the soil ecosystem for the purpose of evaluating possible avenues of pesticide concentration as well as degradation.

Comparable investigations were associated with the movement, concentration and elimination of pesticides in the aquatic environment. The physiological and morphological effects of pesticides on selected aquatic vertebrate and invertebrate organisms was determined. Special attention was directed to the evaluation of the pollution related stress effects on electrophysiology of selected nerves.

Research was also associated with the absorption and metabolism of biologically active chemicals by leaf and fruit tissue. Herbicides were investigated to determine their effect on plant composition. The research with the effects of herbicides on plant composition has provided a practical means whereby the protein content of the edible portions of plants may be increased in developing countries.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - C P.E.H.

1.0058, ANALYSIS OF PESTICIDE RESIDUES

W.A. AUE, Univ. of Missouri, Agricultural Experiment Sta., ***Columbia, Missouri*** 65201 (MO00574)

OBJECTIVE: Develop an analytical services and research program for the experiment station for the analysis of pesticide residues and their metabolites in agricultural products and water. Develop simplified, rapid, and accurate quantitative gas chromatographic methods for the determination of residues of pesticides.

APPROACH: This work will be supplemented with thin layer chromatography and other instrumental methods of analysis.

PROGRESS: Service Work: Chlorinated hydrocarbons in soil, tobacco, and water. Several chlorinated hydrocarbons, thiophosphates, and carbamates in leached soils. Research: A number of gas chromatographic columns were developed, in which the liquid phase is chemically bonded to the surface of the support. These columns show excellent chromatographic behavior and minimal bleed. They have been successfully used in the analysis of chlorinated hydrocarbons. The alkali-flame detector has been modified to allow the analysis of crude soil extracts for chlorinated hydrocarbon residues without purification. At present, accuracy and precision of this method are being determined.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0059, EFFECTS OF INSECTICIDES ON ACTIVITY OF SOIL INHABITING INSECTS

M.L. FAIRCHILD, Univ. of Missouri, Agricultural Experiment Sta., ***Columbia, Missouri*** 65201 (MO00572)

OBJECTIVE: Evaluate effects of various insecticides and rates and methods of application on the activity of soil inhabiting insects in corn fields at certain intervals of time following applications; determine possible lateral or vertical movement of insecticides in soil by measuring biological activity; study the effect of soil type, moisture content, and organic content on insecticidal activity through bioassay.

APPROACH: Soil samples will be taken from numerous soil treatments in corn fields, and the insect activity will be examined. Samples will be taken at various locations in the soil and at several intervals following treatment. A screening-flotation technique will be utilized to remove insects from soil and species and numbers will be recorded.

PROGRESS: Plots at Columbia, McBaine, and McCredie were broadcast- treated with six different insecticides. An infiltrometer was used at two locations near McBaine and one location near Columbia to simulate rainfall on the plots. Soil and water run-off samples were collected from each plot for analysis. The plots at McCredie were used to collect water run-off from natural rainfall. Soil samples were bioassayed and the water run-off samples were analyzed by gas chromatography. Other plots near Rock Port and Tarkio were used to compare insecticide sprays, granular formulations, band width, incorporation methods, layby treatments and dates of application. Soil samples were collected at 14- day intervals. The samples were three inches in depth and three inches in diameter taken from the center of each row. Homogenized samples from each entry were bioassayed. A total of 247 samples were tested. Methods of mass rearing of the black cutworm are being developed for bioassay of soil insecticide activity. Methods of eliminating or reducing incidence of disease and cannibalism are being studied. Studies on effect of temperature, humidity, diets, and various rearing containers on larval growth, pupation, and egg production are underway. Excellent results have been achieved through the third generation.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0060, METHODS FOR DISPOSAL OF SPILLED AND UNUSED PESTICIDES

E.W. LAWLESS, Midwest Research Institute, *Kansas City, Missouri* 64110 (68-01-0098)

Description: The purpose of this project is to develop and compile information describing safe and non-polluting methods for treating spilled and unused portions of pesticides or other agricultural chemicals in terms understandable by, and with equipment available to informed laymen, county agents and public health officials. Information to be gathered and/or developed includes the toxicity and hazards of the materials, detoxification by conversion to innocuous portions, treating of spills in general and on a layman's property, and proper decontamination of pesticide containers and equipment. The effort will result in the preparation of a manual which could be furnished to appropriate officials for distribution of information on specific pesticides.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0061, SOILS, PESTICIDES AND THE QUALITY OF WATER

T.L. LAVY, Univ. of Nebraska, Agricultural Experiment Sta., *Lincoln, Nebraska* 68508 (NEB-12-071)

OBJECTIVE: Identify and characterize the physical-chemical properties of the pesticide-soil-water system which are pertinent to (i) pesticide transport through the soil in infiltrating water, and (ii) pesticide desorption from eroded soil into surface waters. Determine the kinetics and degradation mechanism of picloram and identify the principal degradation products.

APPROACH: The effect of soil properties such as base saturation, soil type, pH, and temperature on the mobility of pesticides in soil columns will be studied. The degree of pesticide adsorption which occurs when various amounts of water are added to the soil in the columns will be measured by assaying sections of the column for the pesticide or its degradation product(s). Nutrient uptake by plants growing in soil-water systems may be altered by an accumulation of the mobile pesticide around the plant roots. The degradation rate of picloram and other mobile pesticides positioned at various soil depths will be evaluated using chemical and bioassay methods. The use of 14(C) labeled pesticides and liquid scintillation counting will permit the detection of trace amounts of pesticide. Extent of degradation of the parent molecule will be assayed using thin layer and gas liquid chromatographic techniques.

PROGRESS: Atrazine was degraded 2 to 3 times faster in topsoils than in subsoils. Each 10 C temperature rise from 15 C to 35 C caused the degradation rate to increase 2 to 3 times. Pesticides will be deactivated more rapidly if they do not move below the surface six inches. Dissipation of dicamba was greater in Sharpsburg silty clay loam soil than in lighter textured low organic matter, Anselmo sandy loam soil. Degradation occurred more rapidly at 35 C than 15 C. Dicamba was most phytotoxic to corn seedlings at pH 4. Although dicamba was taken up by both roots and shoots, root uptake caused greater growth reduction. In laboratory studies the acid form of amiben was more mobile in soils than the ester form which was adsorbed more strongly. This adsorption appears to be closely associated with soil organic matter. Root uptake was more important than shoot uptake. Amiben derivatives which were not susceptible to leaching in laboratory studies provided poor weed control with excessive rainfall.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0062, PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES

B.R. PAYNE, Univ. of Nevada, Agricultural Experiment Sta., *Reno, Nevada* 89507 (NEV00155)

OBJECTIVE: Determine what effect pesticide residues in the environment (air, water, and soil) have on the marketability of crops produced in Nevada. Determine if soils in Nevada formerly treated with DDT and other chlorinated hydrocarbons are at a safe residue level to permit crops to be grown without contamination of the crop.

APPROACH: In cooperation with members of the Plant, Soil and Water Division of the University of Nevada and the County Extension Agents, a thorough survey will be made in each of Nevada's major agricultural areas to determine the degree of contamination by pesticide residues of the air, soils and water in areas that have received heavy applications of chlorinated hydrocarbon pesticides. Many of these fields may be unsuitable for growing crops which have a zero tolerance for the chlorinated hydrocarbon pesticides; therefore affecting the marketability of Nevada's export crops. A monitoring of the same soil and water run-off areas for the substituted pesticides and their metabolites will be made to see if any future problems will arise as a result of the switch from the hard pesticides, the chlorinated hydrocarbons, the less persistent pesticides, the organo phosphates and the carbamates.

PROGRESS: In areas of alfalfa seed production, alfalfa hay is commonly grown for commercial shipment within and out of state. These areas produce over 3 million dollars annually of alfalfa hay. Seed growers use heavy insecticide dosages (usually DDT, toxaphene and Systox) to obtain good insect control. Drift of these insecticides to adjoining hay fields could affect the commercial value of hay if residue tolerances are exceeded. Surveys were made to determine the type of insecticides used in alfalfa seed areas and the potential dangers to the commercial hay growers. Drift studies were conducted in several locations and residue data was collected for DDT and toxaphene. Thirty one samples of alfalfa were analyzed for DDT and toxaphene. DDT ranged from 0.02 to 2.17 ppm residue on baled alfalfa, and toxaphene ranged from 0.1 to 4.35 ppm residue on baled alfalfa. A definite residue problem does exist when DDT and toxaphene are used in fields adjacent to commercial alfalfa hay fields.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0063, PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS

L.L. STITT, Univ. of Nevada, Agricultural Experiment Sta., *Reno, Nevada* 89507 (NEV00106)

OBJECTIVE: Determine modulations on 'scans' of agricultural products, soil and water resources before contamination by pesticides. Develop methods for analysis, identification of pesticides, and their metabolites or degradation products. Determine pesticide residues and their degradation products from research evaluations in various areas of Nevada.

APPROACH: Long range investigations to determine build up of residues from pesticide treatments on previously untreated soils. Modified analytical methods for Nevada conditions. Determinations of residues and their metabolites will be used to set limitations of use.

PROGRESS: Twenty tests were conducted where methyl parathion and GS13005 (phosphate insecticide) were applied at different rates to the first, second, and third alfalfa crops to determine the residue disappearance. Ground equipment was used in 15 tests and detailed records were obtained on amount of spray and toxicant used. Five tests consisted of aircraft application where all operations were monitored. Green alfalfa samples for residues analyses were collected at zero, 1, 5, 10, and 15 days after application in several tests and at zero, 1, 3, 7, and 10 days for other tests. Alfalfa hay samples were collected for all tests by corings of the bales. Residue results indicate a rather rapid disappearance of methyl parathion and GS13005. Investigations were initiated to determine the amount of methyl parathion residues on alfalfa by comparing rehydration of the alfalfa before extraction procedures versus no rehydration. Rehydration of alfalfa hay definitely increased the amount of residue detected. Thirteen paired samples were compared for residues. The average residue for the method without rehydration was 0.72 ppm compared with 1.76 ppm for rehydration. In the rehydration series of tests, residues over 1.0 ppm occurred in 10 of the 13 samples. Rates of methyl parathion were considerably over recommended rates and the harvesting in several cases was at 10 days after application instead of 15 days. Analyses of alfalfa treated with the herbicides atrazine, simazine and GS14254 applied at various rates have been completed.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0064, FATE OF PESTICIDES

W.A. MACLINN, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00901)

Progress: This is a heavily supported interdepartmental research program involving 8 scientific co-investigators and 12 technicians. The study has involved the reaction of 2 herbicides and 4 pesticides on exposure to sunlight, water, plants, and soils in terms of (a) kinetics of the reactions, (b) environmental conditions affecting the reactions, and (c) identification of the intermediate and final oxidation products. At least one family of herbicides containing analine appears to be catalyzed by microbial enzymes (peroxidase) to azo compounds. Thin layer and gas chromatographic methods were devised for the separation and measurement of residues of diazinon and its possible metabolites. Photolysis products were produced from mobam, metobromuron, linuron and monuron. Phototoxicity studies of the phenylurea photoproducts are in progress. Chemical oxidation of an organophosphorus compound, parathion, was studied in water. An intermediate product, Paraoxon, was formed and is considered to be more toxic than Parathion. A herbicide, diphenamid, was shown to reduce absorption of mineral nutrients from the soil in tomato plants. Linuron and chlorobromuron reduced transpiration on a leaf area basis. Degradation of Diazinon and Diazoxon was found to be a function of pH in water. These products undoubtedly have a long residual life in natural waters of a pH of 5.5 to 8.5. The biological oxidation of the herbicide 2,4-D, is tentatively assumed to result in 8CO(2) plus 2H(2) O plus 2HCL. In activated sludge systems the reaction seems to be of zero order kinetics. A technique was developed for recovery, separation and confirmation of four pesticides, their oxygen analogs and their organic hydrolysis products in aquatic environments.

SUPPORTED BY New Jersey State Government - Trenton

1.0065, SOILS, PESTICIDES AND THE QUALITY OF WATER

H.E. DREGNE, New Mexico State University, Agricultural Experiment Sta., *Las Cruces, New Mexico* 88070 (NM00149)

OBJECTIVE: Identify and characterize the physical-chemical properties of the pesticide-soil-water system which are pertinent to pesticide transport through the soil in infiltrating water, and pesticide desorption from eroded soil into surface waters. Develop mathematical model(s) which will provide semiquantitative prediction of pesticide movement in soil-water systems based on input data obtained in objective above. Measure pesticide transport through and over soil in the field or in lysimeters, using well characterized initial and boundary conditions.

APPROACH: Determine adsorption, desorption, and movement of 3 herbicides (2,4-D, 2,4,5-T, and picloram) in soils, using laboratory columns, soil thin-layer plates, bioassay, radiotracers, and large greenhouse lysimeters.

PROGRESS: 2,4-D is capable of persisting for months in a water- logged soil. Approximately 40 percent of the 2,4-D applied to the surface of a slowly permeable (0.3 ml/hour) silty clay loam was recovered in the leachate after continuous leaching over a period of ten months. Bioassay tests of the soil after leaching showed that 2,4-D remained in the soil at phytotoxic levels, using cucumbers as the test plant. Single factor correlation between 2,4-D movement and soil organic matter level, clay content, carbonate content, and pH was poor in six soils from New Mexico that were tested by soil thin-layer chromatography. The importance of any one soil factors tends to be obscured when other factors vary simultaneously or at random. Preliminary tests on soil thin-layer plates indicated that relative solubility of 2,4-D and 2,4,5-T is a good predictor of their movement. It should also be a good indicator of absorption and desorption by soils.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0066, SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II

P.J. WIERENGA, New Mexico State University, School of Agriculture, *Las Cruces, New Mexico* 88001 (C-2165)

Saline soils constitute a large fraction of irrigated soils in the western United States and in other irrigated areas throughout the world. The conventional method for controlling soil salinity is to leach soils by applying large amounts of water. This process is a costly use of water, and contributes furthermore to salt pollution of groundwater supplies and to high salt levels in drainage water. Recent studies indicate that soil profiles may be leached more efficiently by applying smaller quantities of water.

The proposed study involves use of large, well instrumented lysimeters to determine the magnitude and nature of soluble salt movement under unsaturated soil water conditions. During each of several irrigation treatments continuous measurements will be made of the soil temperature, the soil-water content, the salt content, the composition of the soil extract and the concentration and composition of the leachate. Treatments will consist of irrigating with various quantities of irrigation water differing in salt concentration and ionic composition. The movement of nitrogen, phosphorus and pesticides will be studied in homogeneous and stratified soil profiles. The data obtained from the lysimeters will be used as input datas for a computer simulation program for predicting salt movement under unsaturated flow conditions. Comparisons will be made between observed and computed rates of salt movement under various irrigation regimes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0067, AN EVALUATION OF THE INSECTICIDE 'SEVIN' AS A WATERSHED POLLUTANT

J. BREZNER, State University of New York, School of Forestry, *Syracuse, New York* 12224 (WO1602)

OBJECTIVE: Provide information upon which to judge the potential of 'Sevin' as an environmental pollutant in forested areas.

APPROACH: A study area established on the Shackham Brook Watershed in central New York encompasses a 'treatment' and 'control' subwatershed. The treatment area will receive an aerial application of Sevin; then samples of soil, water, and aquatic insects will be taken at frequent intervals to be tested for the presence and concentration of Sevin residues.

PROGRESS: During the first two years of the study, preliminary surveys were completed and were followed by spraying operations. Techniques were devised and determined to be adequate. Tests of water and soil samples showed no residues of Sevin. Insect populations were negligibly affected.

SUPPORTED BY U.S. Dept. of Agriculture - F.S.

1.0068, ENVIRONMENTAL BIOLOGY - BIOGEOCHEMICAL CYCLING IN ECOLOGICAL SYSTEMS

G.M. WOODWELL, Brookhaven Natl. Lab., *Upton, New York* 11973 (AT(30-2)GEN-16)

The objective is measurement of the total inventory and rates of flux of nutrient elements through both terrestrial and certain aquatic ecosystems of Long Island. Studies have included an inventory of DDT residues in a Long Island estuary. One of the principal tools in the measurement of nutrient flux in the forest is a lysimeter plate, capable of collecting water that would normally percolate into the water table. Studies with these plates have shown that a forest has mechanisms for retaining nutrient elements; these mechanisms break down under irradiation and other disturbances. Nutrients lost in this way to the water table contribute to the eutrophication of the estuarine bays along the South Shore of Long Island.

Results: Data are now available on the total inventory of nutrients in the forest, inputs in precipitation and certain data on losses of nutrients into the water table.

SUPPORTED BY U.S. Atomic Energy Commission

1.0069, INTERACTION OF HERBICIDES AND SOIL MICROORGANISMS

D.C. TORGESON, B. Thompson Inst. Plant Res., *Yonkers, New York* 10701

Description: To isolate and characterize microbial species for complete or partial herbicide degradation, to characterize in relatively simple culture media the rates of degradation of this group of structurally related herbicides, to study the influence of environmental factors such as clay supplemental substrates, oxygen and pH levels and previous adaptation to structurally similar compounds, to identify the routes of degradation products, and to determine if microorganisms capable of rapidly degrading a herbicide can be used to decontaminate soil and water.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0070, MULTI-DISCIPLINARY RESEARCH IN POLLUTION

D.G. BARNES, Saint Andrews Presby. College, Undergraduate School, *Laurinburg, North Carolina* 28352

The research consists of two sub-projects: 1. The use of a fast equilibrating ecosystem technique for the study of effects of water pollution on microorganisms. Small containers are placed in water source for two days. These are returned to the lab and placed in large samples of water from the same source. The monitored organisms are cessile ciliates which can be easily observed and fate determined with a microscope. Initial use of the technique has been in association with thermal pollution studies. Experiments with chemical pollutants are planned. 2. The fate of persistent insecticides applied to cotton fields in southeastern North Carolina. Isolated soil bacteria strains will be administered locally-used insecticides in order to determine the biodecomposition agent(s). Measurements of volatilization from these soils will also be made.

SUPPORTED BY Research Corporation - New York, N.Y.

1.0071, MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS

P.C. KEARNEY, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (0710-08-05(C))

OBJECTIVE: Determine the lateral and vertical movement in soils of known physical, chemical, and mineralogical properties of several herbicides differing in physical and chemical properties.

APPROACH: The presence of herbicides in and on soil surfaces caused by lateral and vertical movement will be determined in a well defined watershed with detailed past information on cropping history, fertilizer treatments, soil physical properties, climatic conditions, and hydrological data. Herbicides in soil and water samples will be assayed using appropriate analytical methods, including colorimetric, spectrophotometric and gas chromatographic procedures. All data will be subjected to appropriate statistical analyses, and correlated with the soil and climatic data pertaining to the areas receiving herbicide applications.

PROGRESS: This project was initiated in 1967 to study (a) movement of picloram, 2,4-D, 2,4,5-T, and dicamba in surface and ground water and (b) distribution and persistence of the herbicides in soil. Water samples collected from flumes at the base of each watershed during and after rain storms in 1967 contained 2,4-D, but concentrations of picloram and dicamba were below the limits of detection. The highest concentration of 2,4-D was 28 ppb. After the 1969 applications, 2,4,5-T was detected in water samples taken at the base of watershed 2 during the first and second storms. The highest concentration was 48 ppb. Herbicides were present in surface runoff water collected at the base of the 0.05-acre plots. In 1968 concentrations in surface runoff at the base of the small plots were 1224, 583, and 229 ppb for 2,4-D, 2,4,5-T, and picloram, respectively. Highest concentrations of the herbicides in surface runoff at the base of the small plots were found in 1969 when the application rate was 4 lb/A. Samples taken after the first storm causing significant runoff contained the highest concentrations. These were 1882, 681, and 4187 ppb for 2,4-D, 2,4,5-T, and picloram, respectively.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

1.0072, SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT

J.F. LUTZ, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC03043)

OBJECTIVE: Determine draw-down patterns of water table by use of electric analogue. Attempt to measure hydraulic conductivity of undisturbed soil cores and relate it to soil properties. Study nature and magnitude of forces holding water films on clays and relate these to hydraulic conductivity.

APPROACH: Further work will be done on the effects of phosphate on the colloidal-physical-chemical properties of clays especially on the hydration of the clay studies will be made on a number of North Carolina soils with emphasis on field capacity and wilting percentage determination. Soil moisture and bulk density determinations will be made on soils under a number of different cultural management and tillage practices to determine the effects of these different practices upon the properties mentioned.

PROGRESS: A. Studies were made on the residual effects of heavy applications of P on the physical properties of soils. Unfortunately the original check plots (1956-64) were fertilized in 1965 and in 1966, so there is no longer a true check plot. The heavily-phosphated plots still have about the same good physical properties as during the 1956-64 period. Fertilizing the original check plots improved their physical properties, thus eliminating differences between the 'check' and the high-P plots. The high-P plots had high total, and available, water- holding capacities, with the greatest increase being in the loosely held water that would be more readily available. The increase in water- holding capacity is caused by an increase in charge of the clay particles, as shown by work with pure clay minerals. Modulus of rupture of packed briquets was correlated with the ratio exchangeable-Ca/exchangeable-Al. B. Soil physical properties that affect water- holding capacity and water movement in soils have been determined on many of the major soil series in the State. The determinations include total porosity, pore-size distribution, bulk density, and a soil moisture characteristic curve from 0 to 15 bars. This information will be useful in soil management, particularly with respect to irrigation, drainage, and leaching of fertilizers, herbicides, etc. Leaching of the chemicals is important because the losses reduce their effectiveness, and may cause contamination of groundwater. This information will serve as a basis for work currently being done on herbicide and fertilizer losses from soils.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0073, NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION

J.F. LUTZ, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC03261)

OBJECTIVE: Determine direct contribution of fertilizers to nitrogen and phosphorus contamination of surface and subsurface runoff water from soils as affected by form, time and rate of fertilizer application, crop to which applied, soil properties, and meteorological and hydrological conditions. Lateral and vertical movement of several herbicides in soils and herbicide loss in surface and subsurface runoff from soils of different physical, chemical, and mineralogical properties.

APPROACH: Properly equipped, sealed watersheds will be treated with recommended rates of N, P, and selected herbicides and the amount of N, P, and herbicide in the runoff (surface and subsurface) over the flume determined. Losses of N and P in drainage water from other areas will be determined by analyzing water from tile outlets.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0074, EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA

R.J. MCCRACKEN, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC05158)

OBJECTIVE: Accumulate hydrologic data from watersheds in the Latin square design for rainfall, runoff, evapotranspiration and analysis of soil temperatures.

APPROACH: Two waterheds are being held in readiness for possible studies of pesticide movement in the soil. Interim analysis of data will continue.

PROGRESS: The vegetative cover sequence was completed in July, 1968 on the four experimental watersheds in western North Carolina, as provided in the Latin square statistical design. (These four covers were improved pasture, heavily grazed pasture, corn and wheat.) Collection of hydrologic data cooperatively with TVA was reduced in scope and intensity with the completion of the vegetative cover cycle. Collection of soil samples to evaluate bulk density and porosity changes as a function of vegetative cover and management continues as a terminal phase. Main effort is now being concentrated on summarization of the hydrologic and agronomic data from 18 years of study, preparation of final reports - including extensive statistical analyses using computer programs, and collection of terminal data.

SUPPORTED BY North Carolina State Government - Raleigh

1.0075, PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER

T.J. SHEETS, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC05015)

OBJECTIVE: Perform analytical phases of research jointly undertaken by the Pesticide Residue Research Laboratory and cooperating departments on the disappearance of pesticides from plants, animals, and soils. Cooperate with IR-4 project personnel to establish tolerances and label clearances for minor uses of pesticides. Determine movement of selected pesticides in runoff from cultivated fields and downward into soil profiles and ground water.

APPROACH: Experimental samples will be collected by personnel in cooperating departments and samples will be analyzed for pesticides at different times after application. Residue data on minor uses of pesticides will be submitted to the IR-4 project coordinator to assist in developing tolerances. Under Objective 3 selected pesticides will be applied to soils under field conditions, and samples of soil and surface runoff will be collected periodically and analyzed for residues.

PROGRESS: An electron-capture gas chromatographic method was developed for the determination of trifluralin and daxtron in soil and water. The method will detect as little as 10 ppb in soil and 1 ppb in water. Residues of DDT were determined on sweet potatoes removed from storage at several times after dusting for sweetpotato weevil control. Residues on unwashed potatoes ranged from 0.16 to 9.2 ppm. On washed potatoes the range was 0.09 to 2.3 ppm. These data were used to support a request for extension of the 7 ppm tolerance of DDT on sweet potatoes. Experiments were initiated to study (1) movement of DDT, toxaphene, and trifluralin in surface washoff from cotton fields and (2) movement and persistence of the three pesticides in soil. Preliminary results indicate that 50 percent or more of the pesticides in washoff from heavily sprayed fields was associated with suspended particulates that were retained by paper filters. Concentrations of daxtron in washoff from peanut fields were greatest during the first two rains after application. Thereafter, concentrations decreased rapidly to low levels (about 1 ppb). About 5% of the daxtron applied was found in surface washoff from a sprayed sandy loam soil over a 5-month period.

SUPPORTED BY North Carolina State Government - Raleigh

1.0076, INACTIVATION AND LOSS OF PESTICIDES FROM SOIL

S.B. WEED, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC01062)

OBJECTIVE: Determine mechanisms of inactivation and loss of pesticides by/from soil colloids by studies of retention and release; movement of water through soil; non-biological degradation.

APPROACH: Retention and release of selected pesticides by reference inorganic and organic adsorbents studied as functions of adsorbent type, complementary ions and molecules, pH, and solution composition using adsorption isotherms, column chromatography, etc. Analytical techniques include X-ray diffraction, infrared adsorption, and D.T.A. Movement of pesticides studied using soil columns and related to soil properties and pesticide characteristics. Nonbiological degradation of pesticides studied as a function of adsorbent type, chemical environment, moisture content, etc. System will be treated for removal of all biological effects on degradation.

PROGRESS: 1. Diquat adsorbed by montmorillonite is not herbicidally active until the amount absorbed approaches the clay CECp. Inorganic cations (K, Cs, Ca, Mg, Ba, Al) do not effectively exchange adsorbed diquat, and presence of these ions in the growth medium does not increase diquat availability. However, addition to the growth medium of an organic cation (N-(4-pyridyl) pyridinium chloride) capable of desorbing diquat from montmorillonite makes the diquat available to plants. 2. Malathion adsorbed by montmorillonite saturated with polyvalent inorganic cations is readily recovered by extracting the aqueous suspension with CCl(4). Clay saturated with monovalent cations retained part of the malathion, suggesting that bonding directly to the cation is less readily broken than a water-bridge bond. 3. CO and PO groups are actively involved in bonding of organophosphates to montmorillonite. No evidence was found for bonding through the PS group. 4. Adsorption of monuron and fenuron to Ca-monmorillonite decreased but did not prevent their release to dilute CaCl(2) equilibrating solutions. Monuron was more readily removed than fenuron. 5. The results suggest that adsorption via coulombic attraction may inactivate organic herbicide molecules; adsorption via less energetic bonds may at most decrease the tendency to move. These findings help explain the fate of pesticides added to soils.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0077, FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL

M.S. QURAISHI, North Dakota State University, Agricultural Experiment Sta., *Fargo, North Dakota* 58103 (ND-H-05-016)

OBJECTIVE: Determine factors influencing magnitude, and persistance of insecticide residues occurring in food, forage and oil crops. Determine rate for the disappearance of commonly used insecticides from soil types. Determine magnitude of movement of selected insecticides and role as possible contaminants of water sources.

APPROACH: Magnitude of residues of selected insecticides and metabolites ascertained on potatoes, sugarbeets, oil crops, grassland range and soil, chemical and biological methods. Factors influencing magnitude and degradation of residues will be ascertained. Identification of metabolites will be made and analytical techniques will be modified or developed.

PROGRESS: Work with Temik residues has been continuing, and degradation of Temik in soil under laboratory conditions and in the field has been studied. Leaching of Temik by water from treated soil and its persistence in water have also been investigated. The insecticide degrades readily in soil at temperatures between 27-34 C. in 8-10 weeks. It can be easily leached from soil by water, and is more persistent in water, though sunlight accelerates its break down. Potatoes and sugar beets treated with Temik according to recommendations were not found to contain detectable residues at the time of harvest. Volatilization of chlorinated hydrocarbon insecticides from treated surfaces, and its contribution to environmental pollution was studied. Small amounts of 2,4-D esters are used for improving the color of potatoes in the Valley. Residues of PGBE ester were determined in treated potatoes in cooperation with Dr. Nelson (project H-12-14). Potatoes treated at 2 and 4 oz. per acre yielded negligible residues. Residues of DDT were determined in samples of soil collected from areas treated for Mosquito Control. Most of the samples contained residues in the range of 4-30 ppm. Two samples contained approximately 1000 ppm. Further investigations are in progress. An interesting aspect is the finding of DDD in these samples. Evidently biochemical and chemical reactions favor conversion of DDT to DDE as well as to DDD.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0078, THE CYCLING OF CL-36 LABELED DDT IN NATURAL ECOSYSTEMS

T.J. PETERLE, Ohio State University, School of Arts, *Columbus, Ohio* 43212 (AT(11-1))

Prior experience in the use of isotope-labeled pesticides has demonstrated that this is a useful and economical way for determining the transfer of these organic compounds in ecosystems. This project will attempt to determine the transfer of the Cl-36 DDT through a terrestrial system. Radioassay procedures will be used to qualify the level of the insecticide and its metabolites in the various physical and biological components of the ecosystem. Since the radioassay procedures will assess only the labeled DDT applied, total body burdens will reflect only that DDT accumulated from the study area. Some artificial exposures in time and space will be made to determine rates of accumulation for the various species present on the treated area.

SUPPORTED BY U.S. Atomic Energy Commission

1.0079, FATE OF POLLUTANTS IN GROUND WATER

M.R. SCALF, U.S. Dept. of the Interior, Federal Water Quality Admin., *Ada, Oklahoma* 74820

Traditionally, it has been and continues to be the practice of water users in the High Plains area of West Texas and Eastern New Mexico to recharge aguifers with playa lake water. In doing so, the aquifer recharged risks contamination by chlorinated hydrocarbons and nitrates resulting from agricultural practices. It is of concern that chlorinated hydrocarbons, in particular, adsorb to aquifer material in the near proximity of the recharge well and then are released in high concentrations when that well is pumped. This project is being conducted cooperatively by the Robert S. Kerr Water Research Center of the Federal Water Pollution Control Administration and the Southwestern Great Plains Research Center of the U.S. Department of Agriculture. The experiment will be at the latter's installation at Bushland, Texas.

The scope of this project will be to determine the distance which pollutants travel in a fresh water aquifer under recharge conditions and the temporal distribution of these concentrations when that same well is pumped.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

1.0080, EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS

R.G. MENZEL, U.S. Dept. of Agriculture, Agriculture Water Mgt. Lab., *Durant, Oklahoma* 74701 (SWC-027-EC-1)

OBJECTIVE: Determine when, under what conditions, and what extent the use of agricultural chemicals is impairing the quality of our water resources; develop practices to minimize the movement of contaminants into ground and surface waters.

APPROACH: Studies will be conducted in laboratories for the development of principles and concepts which will then be tested on field plots or small watersheds. Soil and water samples from treated plots and watersheds will be collected and analyzed to determine loss of chemicals by runoff. Soil profiles of selected areas will be sampled and analyzed to assess the effect of past management practices on the movement of nitrate and other contaminants through soil.

PROGRESS: Accomplishments during 1969 were mainly in research planning, recruitment, and instrumentation of the Laboratory rather than in technical results. Goals are: (1) a continuing national evalutation of potential agricultural soil and water pollution problems; (2) establishment of reliable sampling and processing methods for field studies on such pollution; and (3) obtaining field data on movement of agricultural chemicals through cooperation with various locations of the Soil and Water Conservation Research Division. Instruments that have been installed and tested include a radiation analyzer, spectrophotometer, atomic absorption flame photometer, microscopes, and pH meters. Work has started on the design of a moisture flux meter which is to be used in studies on movement of agricultural chemicals in ground water.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0081, BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS

P.W. SANTELMANN, Okla. St. Univ., Agricultural Experiment Sta., *Stillwater, Oklahoma* 74075 (OKL01324)

OBJECTIVE: Determine the effects of climatic and edaphic factors on movement, persistence and toxicity of herbicides in the soil.

APPROACH: Soil characteristics determining the effect of biological decomposition, absorption, volatilization, and leaching on the phytotoxicity and persistence of the herbicides in Southwestern soils will be evaluated. The persistence under field conditions will be determined on two contrasting representative soil types used in cotton and grain sorghum production. Dissipation studies using controlled temperature and humidity cabinets and the greenhouse will include soil variables of moisture tension, organic amendments, pH, temperature, and fertility level. Using basic hydrodynamic and chromatographic models, information will be provided for describing the mixing of the herbicides in a soil-water system. Using field sited and controlled methods for altering the soil-water redistribution a relationship between the volume of water applied and the amount of herbicide moved will be studied.

PROGRESS: A cooperative regional soil bioassay technique experiment was developed and evaluated. No one assay evaluation procedure was uniformly best. The influence of CaCl(2) concentration on the mobility and adsorption of prometryne and fluometuron was studied. Calcium saturated loamy fine sand and loam soils were used. More fluometuron was adsorbed in the presence of 0.01 N than 0.5 N CaCl(2) in both transient and adsorption isotherm systems. Prometryne adsorption was greater in the presence of 0.5 N than 0.01 N CaCl(2) in both soils. Prometryne mobility was retarded, owing to adsorption, in the presence of 0.5 N CaCl(2). The influence of soil textural stratification on the movement of fluometuron was studied. The texturally stratified soil columns showed significant differences in the relative fluometuron concentration distribution. Not all textural stratifications gave a difference and the results did not relate to total porosity differences between the two soils. The greater the pore size range in the second soil of the stratification the greater mixing and early arrival of the herbicide in the effluent.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0082, MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES

M.E. CORDEN, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (OREO0457)

OBJECTIVE: Decomposition products of fungitoxic chemicals in soil and influence of soil composition, pH, temperature, moisture and biotic population on the decomposition. Accumulation of fungicides and their decomposition products in soil, soil-water, and plants, and effects of environmental factors on accumulation. Role of spore exudates on solubilization of copper from various compounds by fungi that are susceptible and fungi that are relatively resistant to the toxic effects of copper. Metabolic site of action and effects of selected fungicides on catabolic, anabolic, and biosynthetic processes in fungi that are susceptible and fungi that are relatively resistant.

APPROACH: New techniques will be developed to test fungicidal activity of new chemicals. Innate toxicity, penetration of soil and various plant materials, and residual effectiveness will be measured. Standard chemical and microbiological assays will be employed to qualitatively and quantitatively measure fungicide decomposition in soil, water, and plants. Normal metabolic pathways in fungi resistant and susceptible to selected fungicides will be studied by radiorespirometric methods using C -labeled glucose and other substrates. The influence of selected fungicides on the enzyme systems in these pathways in intact fungal cells will be measured to determine the mode of action of the fungicides.

PROGRESS: Continued studies of the metabolism of Endothia parasitica have shown that this fungus excretes large amounts of oxalate that precipitate as calcium oxalate trihydrate in nutrient-agar culture at the periphexy of the fungal colony. Mycelial growth of Endothia is greatly retarded when calcium oxalate accumulates, but retardation is reversed by relatively high concentrations of copper and iron salts that prevent accumulation of calcium oxalate. Eleven other metal cations failed to prevent formation of calcium oxalate. Interaction of copper and oxalate ions to form a non-toxic complex accounts for enhanced growth in the presence of toxic levels of copper and high oxalate concentrations. A direct correlation between sulfur content and the susceptibility of Fusarium oxysporum f. lycopersici to methylisothiocyanate (MIT) has been discovered. Sulfur deficient spores are highly resistant to MIT, whereas high sulfur levels in the spores is associated with increased sensitivity to this fungicide.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0083, BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM

R.F. TARRANT, Oregon State University, U.S.D.A. Pac. Nw. Forest Sta., *Corvallis, Oregon* 97331 (PNW1603)

OBJECTIVE: Elucidate the manner in which chemicals behave in various parts of the forest environment and their impact on the biota, in solving problems of environmental pollution connected with forest use of economic chemicals.

APPROACH: Develop information leading to better understanding of the principles of chemical behavior in the forest environment; through the use of mathematical models, predict the behavior of a given chemical in a given environment; and assess the impact of chemicals on living organisms.

PROGRESS: The systemic insecticide, phorate, persists in a forest environment for as much as 18 months. Tannin content of Douglas-fir bark used as a mulch is not harmful to soil microbes. Tree barks have a number of potential uses in agriculture and are chemically and physically adaptable to beneficial utilization. Herbicide residues in fall runoff from treated lands are greatest when the chemicals are applied in late summer and the first fall storms are of high intensity. Relative rates of degradation of phenoxy herbicides and picloram are not influenced by starting concentration. Amitrole, 2,4-D, 2,4,5-T, and picloram are degraded in forest floor material but at markedly different rates. Primary root elongation is inhibited and abnormal lateral root proliferation is observed in two-day-old pea seedlings treated with a variety of herbicides. A soluble cytoplasmic protein associated with zones of meristematic activity or tissue expansion has been found in roots of pea seedlings. A method has been developed to isolate this protein by ammonium sulphate fractionation and preparative scale gel electrophoresis. No appreciable movement of DDT from forest floor to mineral soil was observed after aerial application of the chemical. Picloram herbicide had no significant effect on microbial activities in three soils of different characteristics. Nitrogen in avalanche debris has been shown to develop as a result of nitrogen fixation by Sitka alder.

SUPPORTED BY U.S. Dept. of Agriculture - F.S.

1.0084, PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS

V.V. VOLK, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00873)

OBJECTIVE: Identify and characterize the physical-chemical properties of the pesticide-soil-water system which are pertinent to (i) pesticide transport through the soil in infiltrating water, and (ii) pesticide desorption from eroded soil into surface waters. Develop mathematical model(s) which will provide semiquantitative prediction of pesticide movement in soil-water systems based on input data obtained.

APPROACH: Oregon soils with known chemical and physical properties will be leached with water solutions of 2,4-D, 2,4,5-T, and picloram. Upon leaching, the movement of the herbicide will be ascertained through radioisotope assay. As an aid to interpretation of the results of the movement studies, adsorption and desorption isotherms will be prepared for the same soils and chemicals. Having obtained the distribution of a chemical through the soil column as a function of leaching, soil, and chemical variables, an attempt will be made to relate results to a mathematical model used to predict movement. The relative importance of soil and chemical variables considered in the model will be adjusted so that chemical movements in a soil profile may be made.

PROGRESS: The movement and adsorption of 2,4-D acid in selected Oregon soils were studied as a function of pH, organic matter, and the presence of acidic cations. A decrease in the movement and an increase in adsorption of 2,4-D acid could be induced by the presence of Fe , and Cu cations on the exchange sites. The reduced 2,4-D mobility was attributed predominantly to the decreased pH of the soil with acid cation saturation. However, evidence was observed to indicate the formation of a complex between the 2,4-D and the hydrated Fe, Al, and Cu. Equilibration of the natural and the Fe, Al, and Cu saturated soils with 50 ppm of 2,4-D at 25 C for 24 hours showed the 2,4-D adsorption to decrease in the following order: Fe-soils, Al, Cu-soil, natural Lookout silt soil. Water solubility of the 2,4-D salts of Fe, Al, and Cu increased from 195 to 354 to 1069 ppm respectively. The effects of pH and extractable aluminum on the 2,4-D adsorption appeared to indicate that adsorption was directly associated with the degree of dissociation of the 2,4-D acid as governed by the pH of the system.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0085, PESTICIDE MOBILTY AND DEGRADATION IN SOIL-WATER SYSTEMS

V.V. VOLK, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

The objectives of the project are to identify and characterize the physical-chemical properties of the pesticide-soil-water system which are pertinent to 1) pesticide transport through the soil in infiltrating water, and 2) pesticide desorption from eroded soil into surface waters.

Soils have been collected and characterized. Desorption and adsorption studies have been completed with 2,4-D on several Oregon soils. Picloram adsorption studies on nine Oregon soils as a function of surfactant concentration have been complete.

SUPPORTED BY Oregon State Government - Salem

1.0086, CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS

R. HILTZ, M S A Research Corporation, *Evans City, Pennsylvania* 16033 (68-01-0100)

Description: The purpose of this project is to develop and demonstrate methods to confine spills of hazardous materials on land by use of polyurethane compounds, and low and high expansion foamed inorganics. Selected potential high hazardous materials, including ammonia, chlorine, acrylonitrile, acetonecyanhydrin, methyl alcohol, phenol, and an organic mercury solution, will be used to determine an appropriate compatible foam, structurally stable for creating foam dikes. The methods are to result in a portable high capacity foaming device which can be deployed immediately following a spill, handled, for example, as a backpack and installed and carried on transporting vehicle.

1. PESTICIDE RESIDUES AND AQUATIC ENVIRONMENTS

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0087, PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER

J.M. BOLLAG, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01761)

OBJECTIVE: Observe the response of microorganisms in soil and water to specific pesticides; evaluate microbial activity by product identification; establish mechanism of detoxication.

APPROACH: Microbes from soil and water will be cultured and exposed to specific pesticides. Product identification will be by chromatographic, spectrophotometric and other procedures.

PROGRESS: The decomposition of the pesticide Sevin, 1-naphthyl N- methylcarbamate, was investigated with several microbial isolates from soil. Its transformation was followed periodically by different chemical methods. It could be established that all the isolated microorganisms hydrolyzed Sevin to 1-naphthol. A fungus, identified as Fusarium solani, metabolized 1-naphthol rapidly, whereas one bacteria, a gram negative coccus, degraded the hydrolysis product gradually and a third isolate, a gram positive rod, accumulated it. Since 1-naphthol was identified as a metabolic product, its C-ring labeled form was added to the growth medium and the disappearance of radioactivity compared with that of the side-chain labeled C-Sevin. F. solani decreased the radioactivity of the labeled Sevin almost completely whereas only 20% of the radiocarbon from 1-naphthol disappeared, but the remaining radioactive compound constituted a new product. The bacterial coccus, however, was active in degrading the radioactivity of the ring labeled 1-naphthol but a considerable amount of the radiocarbon from the metabolized Sevin remained in the medium. The mixed culture of the two microbes was very effective in degrading Sevin as well as 1-naphthol and this suggests that complete biodegradation is performed in combined growth. Studies have been initiated in order to determine the microbial decomposition of metobromuron and maloran. Tentative evidence was received that the two ureas are degraded to the corresponding anilines.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0088, ANALYTICAL METHODS FOR PESTICIDES AND PESTICIDE DEGRADATION PRODUCTS

C.D. ERCEGOVICH, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01527)

OBJECTIVE: Development of improved analytical methods for residues of pesticides and their degradation products.

APPROACH: Existing methods for the determination of pesticide residues and degradation products will be critically examined for sensitivity, accuracy, reproducibility and simplicity. Special emphasis will be placed on pesticides in common use, and on pesticide degradation products, soil, water, and other media.

PROGRESS: Compounds possessing nitro groups are reduced to the corresponding amino group, then diazotized with nitrous acid and coupled to fibrinogen. Antibodies of the azoprotein are developed in rabbits over a 30-day period. Ring precipitation and passive hemagglutination tests demonstrate that the antibodies yield a high degree of specificity to dilutions of 1:10 parts of azoprotein antigen, but that impurities in the antigen cause undesirable cross reactions. Improved methods for removal of impurities from azoprotein and changes in injection schedule may increase specificity, sensitivity and reduce cross reactions. Present methods for analysis of CIPC residues in alfalfa and clover are unsatisfactory. A more efficient method has been developed using the Bleidner apparatus for hydrolysis and recovery of CIPC and cellulose column chromatography for removal of interfering plant materials after color development. The procedure is sensitive to .04 ppm. Work indicates possibility of detecting less than 1 ng of cholorotriazines by electron capture GLC. Method is based on reacting the herbicide with HFBI and using an OV-210 column. Search for proper reaction conditions for soil and plant samples is necessary to achieve same sensitivity attainable with in vitro samples. Separation of chlorotriazines from their metabolites in ethanolic plant extracts by ion-exchange chromatography has been restudied.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0089, FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS

D.E. FREAR, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01532)

Objective: Follow the disappearance of pesticide residues in media other than raw agricultural commodities. Qualitatively and quantitatively identify the degradation products resulting from the breakdown of pesticide residues in media other than raw agricultural commodities.

Approach: Measure quantitatively pesticide residues remaining at known time intervals following application in various types of soils, water, plant by-products, silage, dairy products, feed stuffs. By gas chromatographic methods. Identify and measure any pesticide degradation products which may result from hydrolysis or decomposition caused by heat or processing or other physical or chemical forces. These will be separated by thin layer, column or gas chromatographic means and identified by infrared or other spectral analyses and the use of labelled compounds.

Progress: The disappearance of total chlorphenamidine and its metabolites during the growing season and the residue of these materials at harvest on six fruit crops and Hagerstown silt loam soil has been studied. Of three identified metabolites only N-formyl-2-methyl-4- chloroaniline and the parent compound were found at harvest. Neither chemical nor enzymatic degradation appear to occur in any of these crops. Environmental factors and growth dilution seem most responsible for its disappearance from fruit. The half-life of total chlorphenamidine residues in soil of 20% moisture at 20 C is about 20 weeks. Microbial activity seems to be primarily responsible for its disappearance from soil. Trace amounts of 4,4'-dichloro-2,2'- dimethylazobenzene (DDAB) were detected after six months in non-sterile but not in sterile soil treated with 2000 ppm of chlorphenamidine. The formation of DDAB under field conditions through the practical use of chlorphenamidine appears to be of little significance. The uptake of DDAB in cabbage and corn plants grown in soil containing 50 and 500 ppm was detected at 14 days, but not at 50 days. Evidence of DDAB degradation in corn and cabbage plants has been observed by thin layer chromatography. The persistence of aminotriazole, dalapon, diuron, paraquat and simazine in orchard soils has been investigated and long term studies of lovozal have been initiated.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0090, PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL

J.K. HALL, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01663)

OBJECTIVE: Relate persistence and movement of herbicides to the physical, chemical and mineralogical characteristice of soil types in Pennsylvania. Determine by bioassay and chemical analyses the effects of soil properties and climatic conditions on the minimum soil solution concentrations of different herbicides which are toxic to crop species. Determine the adsorption of herbicides on the colloidal soil constituents. Determine the effect of herbicide residues in soils on nutrient uptake by crops.

APPROACH: Analysis of herbicide residues in soil, water and plant tissue will be carried out by bioassy, UV-adsorption spectrophotometry, and gas chromatography. Nutrient solutions and clay cultures will be used to grow plants in a growth chamber to determine the minimum soil solution concentrations of different herbicides which are toxic to crop species. Infrared absorption spectrophotometry, x-ray analysis and various chemical techniques will be used to study the adsorption of herbicides by pure and soil clay minerals. Uptake of soil nutrients by plants, grown in soils to which a range of herbicide concentrations have been applied, will be measured in greenhouse experiments.

PROGRESS: Losses of atrazine from a Hagerstown silt loam of 8% slope related to rainfall and rates of application of pesticide. Total atrazine concentrations in runoff water in 1967 were 0, 0.77, 1.54, 1.60, 3.39, 5.65 and 7.78 ppm from plots treated with 0, 0.5, 1,2, 4, 6, and 8 lb./A of atrazine. Concentrations in eroded soil the same year were 0, 0.49, 2.16, 8.57, 14.56 and 19.54 ppm, respectively. Atrazine was detected in three collections (3/9) of runoff water in 1968, total ranging from 0.05 to 0.15 ppm. Concentrations in eroded soil were again higher than runoff water at all rates but less than 1967 values. Soil core samples collected at intervals each year indicated that the percentage of applied atrazine decreased from 87% in June, 1967 to 27% in Sept. 1967; and from 19% in Apr., 1968 to 5% in Sept. 1968. Total losses of atrazine in 1967 were 1.05 lb/A (runoff water) and 0.59 lb/A (eroded soil) which equaled 4.9 and 2.7 percent of the total applied. Losses in runoff water and soil in 1968 amounted to 0.02 and 0.04 percent, respectively.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0091, BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS

B.J. GOSSETT, Clemson University, Agricultural Experiment Sta., *Clemson, South Carolina* 29631 (SC00756)

OBJECTIVE: Determine the effects of climatic and edaphic factors on movement, persistence, and toxicity of herbicides in the soil.

APPROACH: The effects of edaphic and climatic conditions on the movement, persistence, and degradation of prometryne (2,4-bis(iso propylamino)-6-methylthio-s-triazine) and C-2059 (3-(n- trifluoromethylphenyl)-1,1-dimethylurea) will be investigated. Such factors as sunlight, soil moisture, temperature, pH, and organic matter content on the persistence and activity of these herbicides will be determined. Undisturbed soil profiles will be obtained by forcing a hollow cylinder into the soil to a depth of 3 feet. These soil columns treated with the two herbicides will be exposed to varying amounts and intensity of simulated rainfall. Bioassays will be conducted to determine the depth to which the herbicides moved in phytotoxic concentrations. Under field conditions, studies will be conducted on various soil types to determine the effect of soil incorporation and depth of incorporation on the performance of these herbicides.

PROGRESS: Under field conditions the performance of trifluralin and fluometuron was investigated as influenced by various spray volumes and incorporation into the soil at maximum uniformity and controlled depths. The rate of each herbicide used was 1/3x, 2/3x, and 1x of the suggested rate. With both herbicides, spray volumes near concentrate levels gave poorer weed control than conventional spray volumes. However, spray volumes as low as 2 gallons per acre gave weed control equal to that of conventional spray volumes. Better weed control was obtained with both herbicides when incorporated at maximum uniformity to a depth of 2 inches than at the 1- or 4-inch depths of incorporation. Incorporation of fluometuron at the 2-inch depth provided better weed control than when applied to the soil surface in the conventional manner and followed by irrigation. The response of cotton did not appear to be significantly influenced by any treatment, but statistical analysis are not complete.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0092, FATES OF AGRICULTURAL CHEMICALS IN SOILS

E.M. WHITE, South Dakota State University, Agricultural Experiment Sta., *Brookings, South Dakota* 57006 (SD00518)

OBJECTIVE: To study the fertilizer element, pesticide and herbicide: contents in agricultural surface-water runoff; vertical movement in soils of different textures and drainage characteristics; management practices that determine the amount added to surface and groundwater runoff.

APPROACH: Surface water runoff from established plots at Madison, Garden City, Cottonwood, and plots proposed at Presho will be analyzed for fertilizer elements (and other agricultural chemicals if applied) to determine the quantity lost with different management practices and different soils. Additional water samples will be analyzed from areas with other soils when the management practices can be ascertained. Soil profiles will be studied to determine the movement and fate of applied agricultural chemicals.

PROGRESS: This project was initiated July, 1969. Runoff samples were collected from runoff plots at Madison and Garden City for analyses of the plant nutrients. Soils in the plots were also sampled for laboratory analyses to determine the relationship between nutrient levels of the soils and the runoff. Vegetation and soil from the Altamont Prairie were sampled twice this fall to establish the nutrient levels prior to freezing, so sample can be collected in the spring to determine the amount of nutrients which could be lost in snow melt runoff.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0093, CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES

P.R. ATKINS, Univ. of Texas, Graduate School, *Austin, Texas* 78712

Description: The purpose of this proposed study is to investigate the quantity and quality of pesticide manufacturing waste streams and to evaluate the methods presently being employed to treat and dispose of the pollutants. The study area involved will be limited to the continental United States and Canada. The project will include: 1. A comprehensive review of the literature dealing with historical, present and projected pesticide usage, manufacture, and waste water treatment. 2. A survey of a number of major manufacturing plants, including site visits and personal interviews where possible. The production process used, the wastes produced, and the treatment and disposal methods utilized will be investigated. 3. A completion and evaluation of the information obtained from the literature, site visits, industry reports, agency reports, research projects, and other sources. 4. The development of recommendations on the type of research needed in this area. 5. The Development of a complete and comprehensive bibliography on pesticide wastes and waste treatment.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0094, PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS

A.D. SCHNEIDER, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Bushland, Texas* 79012 (SWC-012-EBUS-1)

OBJECTIVE: Develop methods, principles, facilities, and economical systems for conserving surface water supplies by ground water recharge including water clarification, wells, and surface spreading.

APPROACH: Water clarification by coagulants and flocculants is studied in the laboratory. Economical field water clarification systems are then developed and tested. Recharge wells, clogging, redevelopment, new drilling methods are studied by analog models, physical models, and field tests. Ground water pollution by recharge is studied in the laboratory and field and methods developed for control.

PROGRESS: Preliminary field and laboratory studies indicated the feasibility of recharging the Ogallala aquifer through the Pleistocene pluvial sediments when the slowly permeable Pullman clay loam or Randall clay is removed. Two basins, 0.1 acre in area, were excavated approximately 3.5 feet to expose the caliche and underlying sediments. Twenty acre-feet of well water was applied to the first basin in 46 days with a maximum percolation rate of 7.0 feet per day occurring at the end of the test. A mixture of well and runoff water, containing an average of 189 p.p.m. suspended solids, was used in the second basin. During the 66-day test period, 14.9 acre-feet of water was recharged with a final percolation rate of 1.5 feet per day. Deep percolation into the Ogallala aquifer 175 feet below the basin was clearly evidenced by a sharp rise in the water table. Recharge basins have a distinct advantage over recharge wells (or shafts) because the studies show that initial infiltration rates can be restored by removing the sediment sealed surface. To study the fate of herbicides introduced into recharge wells, picloram, atrazine, and trifluralin were added to water that was injected into a dual-purpose well for 10 days at 360 g.p.m. The ground-water mound created by recharging was allowed to dissipate for 10 days, and then the well was pumped for 12 days at 570 g.p.m. Ninety-three percent of the recharge water was recovered, and this water contained more than 90 percent of each herbicide injected.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0095, FATE OF HERBICIDES IN PLANTS AND SOILS

E.F. EASTIN, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX01737)

OBJECTIVE: To study fate of herbicides in plants and soils as influenced by environmental factors; determine mechanisms of metabolism and devise methods of modifying rate of dissipation of herbicides.

APPROACH: Standard methods using radiolabelled materials coupled with gas chromatography will be used to study absorption, translocation and fate of herbicides in plants. Effects of light quality, intensity, and duration plus temperature, moisture, soil type and pH on fate of herbicides in plants and soils will be studied. Methods of modifying the rate of herbicidal dissipation will be of two types: modification of the environment and addition of chemicals, or by chemically modifying the herbicide itself.

PROGRESS: A two-dimensional thin-layer chromatographic method for the separation of C-6989 (rho-nitrophenyl-alpha,alpha,alpha- trifluoro- methyl-rho-tolyl ether) and some of its suspected degradation products was developed. Studies were then undertaken to determine the movement and fate of C-6989 in peanuts (resistant) and cucumber (susceptible). Major degradative pathway appears to be cleavage of the ether linkage in both species. Studies were undertaken to determine the relative absorption and translocation of atrazine (2-chloro-4- ethylamino-6- isopropylamino-triazine) in resistant and susceptible selections of corn. Both selections absorbed essentially the same amount of atrazine but the susceptible line translocated more radiolabelled to the shoot than the resistant line. This may result in an overloading of the protective mechanism, resulting in death to the plant. Analyses of stock tanks and ditches indicate that the major loss of picloram occurs in the runoff of the first rainfall. Highest concentration of picloram found in the runoff water was 75 ppb when rainfall occurred within 2 weeks after herbicidal application. There was less than 10 ppb of picloram in the spring runoff from plots treated the following fall. The only indication of ground water contamination was in a well at College Station and this water had less than 1 ppb.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0096, PERSISTENCE AND MODES OF HERBICIDE DISSIPATION UNDER RANGELAND CONDITIONS

C.J. SCIFRES, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX01822)

OBJECTIVE: Determine the various modes of dissipation of herbicides applied for woody plant control. Establish the relative importance of the various modes of herbicide dissipation after their application for woody plant control. Compare the persistence of promising herbicides for woody plant control in rangeland soils, plants, and soil water.

APPROACH: Bioassay and gas chromatographic analysis will be utilized to characterize the residue potential of herbicides applied for control of brush. Herbicide mobility in rangeland soils and soil water and relative rate of herbicide dissipation will be correlated with topography, soil type, rainfall patterns and existing vegetation. Sequential sampling patterns of the vertical vegetation and soil strata will be correlated with rate of relative herbicide movement downslope from the point of application.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0097, INACTIVATION AND LOSS OF PESTICIDES FROM SOIL

A.R. SWOBODA, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX02621)

OBJECTIVE: Determine inactivation and loss of pesticides from soil by: volatilization; retention and release; microbiological degradation; non-microbiological degradation; movement of water through and over soil for the purpose of identifying primary loss processes, relating these processes to soil properties, and predicting pesticide persistence.

APPROACH: Loss of pesticides from soils will be measured in the laboratory using vapor trapping devices. Retention and release of selected pesticides by soils will be studied using adsorption isotherms and column chromatography. The movement of pesticides through and across the soil will be studied in field experiments. Pesticides will be monitored in leaching and runoff waters.

PROGRESS: Work on the movement of DDT and Toxaphene in watersheds in Central Texas was continued. Due to the lack of runoff causing rainstorms during the past year few waters were collected. Work was completed on the toxicity of arsenic to cotton and soybeans in two Texas soils. Arsenic was found to be very toxic to soybeans, especially on Amarillo fine sandy loam soil. Soil tests were investigated to determine toxic levels of arsenic. Arsenic was also found to become very soluble under flowed soil conditions. This reduced soil condition may cause arsenic to become more toxic to plants during a rainy period during the growing season.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0098, MOVEMENT OF INSECTICIDES IN SOIL AND WATER

G.W. THOMAS, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (SWC-024-BELT-10)

OBJECTIVE: Determine the effects of rainfall amount and intensity on the movement of insecticides through soils and in washoff of soil and water; predict the extent of pollution from typical Blackland farming enterprises.

APPROACH: Three small watersheds at Riesel will be sampled periodically to determine the distribution with depth of DDT, toxaphene, and parathion in the soil. Runoff water, ground water, and eroded sediment will be collected and analyzed for these same substances. Two instrumented sites, at Riesel and at College Station, will be used to determine the rate of pesticide movement relative to water movement in clay soils.

PROGRESS: Three small watersheds in central Texas, which are adjacent to each other and in a rotation of oats, cotton, grain sorghum, are being used to monitor pesticide residues in soil and loss in runoff water and sediment. The only insecticides which have been applied to these watersheds have been toxaphene and DDT. Soil samples taken to a depth of 5 feet contained very little toxaphene at depths below 1 foot. DDT tended to be higher in the surface 6 inches than at any other depth, but appreciable quantities of DDT were found throughout the 5 foot depth in some profiles. Profile samples from waterways were found to contain very little DDT and almost no toxaphene. A sample of silt collected in one waterway contained only 0.06 ppm toxaphene and only 0.052 ppm DDT. Only about 20% of the toxaphene and DDT applied in the past 10 years could be accounted for in the soil profiles. Insecticide residues in runoff waters were not of significant concentrations with respect to pollution problems. In the runoff following one storm the DDT concentration reached 1.0 ppb. No toxaphene was found in any of the water samples. Water samples collected from a seep indicates that DDT is indeed moving through the soil profile but concentrations are very small. When the seep initially began to flow the concentration of DDT was slightly in excess of 1 ppb but quickly decreased to less than 0.2 ppb.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0099, MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER

A. WIESE, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (SWC-024-BELT-11)

OBJECTIVE: Determine movement and fate of herbicides with irrigation and rainfall in and from West Texas fields, playa lakes, and recharge wells. Conditions that favor herbicide removal in runoff water will be determined.

APPROACH: Runoff water from about 50 fields will be sampled to determine if herbicides are being removed. Ponds and lakes will be treated with herbicides to study movement and breakdown, and a recharge well will be treated with an herbicide to determine herbicide movement and persistence in the underground aquifer. Models will be constructed to determine soil moisture, soil type, slope, and rainfall conditions that favor herbicide removal from fields. Adsorption of herbicides in mud in lake water and Ogallala sand will be determined in the laboratory. A model will be developed to study herbicide movement in Ogallala sand.

PROGRESS: On five fields in West Texas only 14% of applied trifluralin remained in the soil 3 months after application. On one field each, only 20 and 8 percent of propazine and atrazine persisted 1 month after application. Runoff samples from these same fields contained a maximum of 0.04, 0.05, and 0.04 ppm of trifluralin, propazine, and atrazine, respectively. At these concentrations there would be less than 1.2 pounds of active ingredient in 100 acre-inches of runoff. Trifluralin, atrazine, and picloram were applied to soil in small basins at 1, 1, and 1/2 pounds per acre, respectively, which were later flooded. Trifluralin and atrazine did not get into the water, but detectable amounts of picloram were in the water. Trifluralin disappeared from the soil in 2 months of flooding. Soil samples for picloram and atrazine have not been analyzed.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0100, EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA

J. VALLIANT, High Plains Research Found., *Plainview*, *Texas* 79072

The purpose of the study is to evaluate the effect of recharging with runoff water on the Ogallala aquifer and the ground water quality. By using pumping tests, the effect of suspended solids contained in recharge water upon the Ogallala aquifer are being determined for the area under study. The effect on transmissibility, specific yield, and other characteristics are being evaluated and determinations made as to whether additional desilting methods may be required to avoid clogging the aquifer. The study includes a determination of the movement of pesticides, herbicides, bacteria and other agricultural chemicals through the aquifer. A determination is being made as to whether the playa lake waters recharged are compatible with the ground water with respect to calcium carbonate equilibrium.

SUPPORTED BY Texas State Government - Austin

1.0101, EFFECT OF PESTICIDES ON THE QUALITY OF SURFACE AND GROUND WATERS IN THE WESTERN GULF REGION

W.G. KNISEL, Blackland Conserv. Res. Center, *Temple*, *Texas* 76501 (SWC-024-ETEM-8)

OBJECTIVE: On experimental watersheds, determine disposition of pesticide in runoff, seepage flow, soil, and vegetation, with respect to climate and time after application.

APPROACH: Rainfall and runoff are measured at 7 watersheds of 1.5 and 3 acre drainage areas and a 7.8 acre subsurface drainage area. Runoff measuring structures are equipped for collection of single stage samples of runoff water. Comparisons of pesticide recovery are made between permanent grasses and cultivated areas. Water use and water yield are measured on mesquite infested watersheds.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0102, QUALITY OF IRRIGATION RETURN FLOW

L.G. KING, Utah State University, School of Agriculture, *Logan*, *Utah* 84321

Description: The primary objective is to conduct research on the problems that affect the quality of irrigation flow. This is to be accomplished initially by studies in four areas or sub projects: (1) Precipitation mechanisms in soils as they affect water quality. This phase will be concerned with the changes in the quality of water, as it moves through soils, as a result of precipitation of calcium carbonate, (2) to develop information for predicting the changes in the salinity content of soil and drainage water resulting in changes in the quality of irrigation water and in irrigation management. (3) Managing water in the soil-plant matrix to control the quality and quantity of return flow. (4) Contamination of surface and drainage waters with soil and foliar herbicides. There will be a special emphasis on heavy rates used on canal banks, drains, waterways, etc. It is anticipated that as the specific segments or sub-projects are completed the studies will be expanded to include the broad aspects of water management. This would include such things as consolidation of irrigation companies for water quality control. It would also encompass the economics of water quality improvement and protection.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0103, SOILS, PESTICIDES, AND THE QUALITY OF WATER

R.L. SMITH, Utah State University, Agricultural Experiment Sta., *Logan*, *Utah* 84321 (UTA00678)

OBJECTIVE: Identify the properties of pesticides and of soils that controls the extent of movement of pesticides in and through soils. Ascertain the solubility characteristics of pesticides adsorbed on soil particles and hence the effect of suspended soil on the concentrations of pesticides in water.

APPROACH: Adsorption, flow, and thermodynamic properties of a variety of pesticides will be studied in connection with montmorillonitic and kaolinitic types of clays, sand, and complete soil. Specific compounds will be selected to give carboxyl, carbonyl, amine, amide, and double bonded oxygen, sulfur, or phosphorus position that may interact with clay to exchange with cations present in the colloidal complex of soil materials. Thermodynamic properties of systems consisting of various soil materials and water will be studied. Organic pesticides will then be adsorbed onto the soil solids and the thermodynamic properties will again be studied. In this way the change in properties will be evaluated.

PROGRESS: A study of the soil type role and related factors on pesticide movement in surface waters has recently been initiated. Preliminary tests have shown that exchange of phenoxy herbicides is dependent upon pH of soil and water; organic content; concentration of the herbicide. A major effort is being made to define the role of organic matter in this exchange reaction. A major accomplishment of the projects has been the development of a GLC technique capable of routine measurements for concentrations around 0.1 parts per billion picloram. In addition to GLC, fluorescence measurements are simple, highly reproducible and can be performed on considerably more samples in a given amount of time. It will be a valuable analytical and tracer tool. Detailed degradation studies were made on picloram in water under the influence of light, temperature and pH of water. The compound was significantly degraded photochemically and thermochemically. The primary degradation product appears similar in either process and has been tentatively identified as decarboxglated-picloram (product-I). Work is continuing to determine further degradation or stability of product I and its toxicity. Picloram and product I have been separated and purified on alimina columns. Both have demonstrated considerable fluorescence at certain temperatures.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0104, EVALUATION AND DEMONSTRATION OF IRRIGATION METHODS AND PRACTICES TO REDUCE CONTAMINATION IN IRRIGATION WASTE WATER

B.L. CARLILE, Washington State University, School of Agriculture, *Pullman*, *Washington* 99163

Field research and demonstration studies are proposed to evaluate irrigation techniques and fertilization management practices for minimization of water quality impairment in irrigation waste water. Water and water movements will be measured under both furrow and sprinkler systems at various water application rates and fertility treatments. Suspended sediment in surface waste water will be monitored and the distribution of nutrients and pesticides between the aqueous and solid phases will be examined. Total salt removal under various treatments will also be studied. Urea and ammonium fertilizers in combination with a nitrification retardent and/or slow release fertilizer will be studied in an attempt to reduce leaching losses of nitrogen during early season irrigation for wind erosion control. Porous cups will be utilized to collect samples of soil solution for analysis. These cups will be buried at various depths in the soil and at sufficient locations in and around each plot to measure the quality of water moving through the profile. Techniques for the in situ measurements of soil moisture flux will be further developed and tested in field plots in an attempt to obtain more accurate water mass balance equations under field conditions.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0105, SOILS, PESTICIDES AND THE QUALITY OF WATER

H.H. CHENG, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01811)

OBJECTIVE: Identify and characterize the physical-chemical properties of the pesticide-soil water system which are pertinent to pesticide transport through the soil in infiltrating water, and pesticide desorption from eroded soil into surface waters. Identify the principal degradation products and determine the mechanisms and kinetics of pesticide transformations in soil-water systems. Measure pesticide transport through and over soil in the field or in lysimeters, using well characterized initial and boundary conditions.

APPROACH: Laboratory studies will include examination of the adsorption-desorption equilibria of carboxylic acid herbicides (represented by picloram) in relation to chemical properties of representative soils, the transport of picloram by moving water in various soil columns, and the degradation of picloram and organophosphate insecticides as influenced by soil and environmental factors, such as soil pH, organic matter content, moisture level, aeration, and temperature. Particular emphasis will be on the role of organic matter in organophosphates breakdown. Field measurement will be made to evaluate the extent to which pesticide transport can be predicted from information obtained from the chemical, physical, and biological studies done in the laboratory.

PROGRESS: The original project was terminated with our final contribution in the form of a M.S. thesis: 'Distribution and Transformation of Anhydrous Ammonia in Soil and Effects on Wheat and Pea Foot Rot Fusaria' by R. W. Smiley. Under the revised project, the W- 82 Regional Project Committee has selected two soils from Washington as standards for cooperative study. Bulk quantities of these two soils were collected by horizons, prepared, and distributed to committee members. Physical and chemical properties of the two soils are being characterized and data will be distributed also. Initial research has been on the adsorption and desorption of carboxylic-acid herbicides (2,4-D and picloram) in soils as affected by herbicide concentration, time and temperature of equilibration, and pH of soil. Results indicate that adsorption of herbicide by soil reached equilibrium within 15 minutes of contact. The amount of herbicide adsorbed was dependent on pH of the soil, with increasing adsorption at lower soil pH.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0106, ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS

J.H. DAWSON, Battelle Memorial Institute, *Richland, Washington* 99352 (0710-01-27-(C))

OBJECTIVE: Characterize the major effects of herbicide formulation, placement, and soil management practices on volatility, decomposition, and movement of CIPC, EPTC, trifluralin, picloram, and TCA in soil, water, and plants; and develop prototypes of new formulations, soil management practices, and application of techniques which will facilitate increasing or decreasing persistence and movement of the herbicides.

APPROACH: First investigate physico-chemical properties of the herbicides and biological-physiological relations of the herbicides with the environment to determine which factors are most likely to influence their fate in soils, water, and plants; and then, by using that information, select and explore logical choices of soil additives, soil manipulations, aeration of water, placement techniques, herbicide granule structures, granule coatings, and liquid herbicide formulations to alter persistence and movement of the herbicides in water, soil, and plants in advantageous directions.

PROGRESS: In a soil perfusion system, S-ethyl dipropylthiocarbamate (EPTC) was released to solution more uniformly over a period of 12 days from granules made of zeolite or alumina than from a commercial granular formulation. In a similar system, 4- amino- 3,5,6-trichloropicolinic acid (picloram) was released to solution more slowly from zeolite and alumina granules than from a commercial granular formulation. After 16 days of perfusion, the rate of release of picloam from granules decreased most in montmorillonite, intermediate in zeolite, and least in alumina.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

1.0107, HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER

F.L. TIMMONS, Battelle Memorial Institute, *Richland, Washington* 99352 (0750-09-09(C))

OBJECTIVE: Determine the presence and concentrations of selected herbicides and degradation compounds or metabolites in crops and soils irrigated with water containing known concentrations of each herbicide.

APPROACH: Acrolein and copper sulfate will each be applied to a typical irrigation canal at a known concentration and determinations of concentrations remaining in the water, suspended material, and bottom soil will be made at various distances and time intervals after application. Acrolein, 2,4-D, silvex and two other herbicides will each be applied in three different concentrations to irrigation water which will be applied by overhead and furrow irrigation methods to corn, soybeans, and sugarbeets grown in field plots. Samples of treated water and irrigated soil will be taken at the time and one week after the irrigation. Samples of edible portions of the crops will be taken at maturity. All samples will be analyzed by appropriate methods to determine the presence and concentrations of the herbicide and of important degradation compounds or metabolites.

PROGRESS: Acrolein applied at 0.7 ppm during a period of 6 hours 20 minutes in an irrigation canal. The volume of water flow was 135 cfs and the water temperature was 48 F. Water samples taken at nine locations downstream, 1, 3, 6, 9.5, 12.5, 16, 19, 22.5, and 27 miles below the point of application during 30 hours after treatment, showed a progressive reduction in concentration of copper ion in the water from 0.710 ppm at Mile 1 to 0.269 ppm at Mile 27. The concentration was reduced more rapidly during the first 9.5 miles than during the subsequent 17.5 miles. The total dissipation of applied copper was 44.1% after 9.5 mi. and 62.6% after 27 mi. All fish in live boxes below the acrolein application were killed even at the station 27 mi. below. Volatility of acrolein according to measurements with volatilimeters showed that volatilization accounted for only a small proportion of the reduction in concentration at the unusually low temperature. In an earlier experiment conducted in a similar canal in August 1966 when the water temperature was 63-64 F losses by volatilization were 50% in the first 3 mi. and 90% in the first 10 mi. that treated water flowed down the canal.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

1.0108, DEVELOPMENT OF ON-SITE BIOASSAY METHODS

R.M. BURRESS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Past failures in the use of chemical tools have been caused in part by the complexity of aquatic ecosystems and lack of accurate methods of predicting the results of treatments made under given conditions. Growing awareness of the dire consequences of misusing pesticides has focused attention on the critical need for methods to determine the amount of a particular chemical required to produce a desired result. One of the most promising methods yet tried is that of on-site bioassay in which a chemical tool is tested against target organisms in the target water just prior to full-scale field applicaton.

Field tests will be conducted over a period of at least one year to determine which kind of bioassay container is most suitable from several viewpoints, and how it can be supported and protected. The validity of on-site bioassay results will be evaluated by treating selected ponds in accordance with data derived from on-site bioassays.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0109, INTERFERING SOIL CONSTITUENTS IN DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND WATER

C.W. CARLSON, Univ. of Wisconsin, Agricultural Experiment Sta., ***Madison, Wisconsin*** (SWCW8-BELT-19)

OBJECTIVE: Determine the most effective method for extracting and purifying pesticides from soil types and runoff and drainage waters and develop accurate analytical procedures for estimating pesticide concentrations.

APPROACH: Conduct investigation bases designed to determine accurate analytical procedures for the determination of extremely small concentrations of organic pesticide residues in soils and runoff and drainage water. All soil components which interfere with the final analytical determination will be completely evaluated and the methods and necessity for removal investigated. Analytical procedures which will completely extract pesticides residues from different soil systems and waters will be developed; interferring substances from soil extracts will be identified and methods for effectively removing them developed.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0110, IDENTIFICATION AND DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND RUNOFF AND DRAINAGE WATERS.

G. CHESTERS, Univ. of Wisconsin, Agricultural Experiment Sta., ***Madison, Wisconsin*** (WIS01342)

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Wisconsin State Government - Madison

1.0111, FATE OF INSECTICIDES IN SOIL AND THEIR MOVEMENT IN WATER AND CROPS

E.P. LICHTENSTEIN, Univ. of Wisconsin, School of Agriculture, ***Madison, Wisconsin***

The fate of selected C14-labelled insecticides in different soils will be investigated, followed by studies of the movement of the parent compound and their metabolites in soils with and without water. The effect of biologically different kinds of water on the persistence of the insecticidal substances will be investigated. Using agricultural crop plants as test organisms, environmental factors affecting the penetration, translocation and metabolism of these C14-insecticidal substances will be studied in detail.

SUPPORTED BY Intl. Atomic Energy Agency - Austria

1.0112, GREEN BAY RESEARCH PROGRAM

R.A. RAGOTZKIE, Univ. of Wisconsin, School of Letters, ***Madison, Wisconsin*** 53706

The Program is being developed as a multidisciplinary effort to provide information on the total environment of Green Bay, which presently receives an exceptionally heavy load of industrial and domestic waste via the Fox River. Within a systems framework, the program has a goal objective evaluation of alternate solutions to the pollution problem. Inital efforts will assess the effects of man's socio-economic activities on the aquatic ecosystem as well as the reverse effect of current environmental conditions of the Bay on man's cultural activities. Included in the first phase of the Program are studies dealing with: (1) the nutrient inputs from the Fox and Wolf River drainage basins (2) an acoustic profiling of the bottom and sub- bottom structure of lower Green Bay as related to sedimentation, (3) the primary productivity of algal and plant species, (4) the nitrogen fixation activity of the phytoplankton community in the lower Bay, (5) the role of the sediment environment in the degredation of organochlorine pesticides, (6) the effects of eutrophication on the benthos and plankton communities, (7) the flushing rate of the Bay in terms of the Fox River water, (8) the effects of perceived water quality on recreational pursuits, and (9) the economic impact of commercial shipping and the Seaway on the port of Green Bay.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1B. SURFACE WATERS

(Precipitation, Surface Runoff, Streams, Lakes, Oceans, Aquatic Sediments)

1.0113, METABOLISM OF ENDRIN IN PONDS

R.L. ARGYLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, ***Marion, Alabama*** 36756

Objectives: Endrin when entering the aquatic environment by the accident or when applied, theoretically becomes a part of that environment. Thus it appears desirable to determine its fate starting with its entrance into the water and ending with its degradaion, or its becoming a permanent part of the metabolic system. Therefore the objectives are to: 1. determine the rate of loss from the water, 2. determine the rate of accumulation and loss in fish, vegetation and soil, 3. determine the effect on size and composition of food organism populations.

Procedure: Ponds will be filled with pesticide - free water and stocked with goldfish, catfish and sunfish. Endrin will be placed in the water. Periodically samples of water, fish, soil and vegetation will be analyzed by gas chromatography for endrin content. Organism populations will be measured by plankton net hauls and by plate samplers.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0114, UPTAKE AND RELEASE OF DALAPON IN EARTHEN PONDS

R.L. ARGYLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, ***Marion, Alabama*** 36756

Objectives: To quantitate the uptake and release of Dalapon in water, fish, soil and plants in earthen ponds.

Procedure: Twelve 0.1 acre earthen ponds will be filled with water and 'sprigged' with cattail plants. After a short period of acclimation, fingerling channel catfish, bluegill sunfish and largemouth bass will be stocked into each pond. Dalapon at 0 and 1/3, and 3 times the recommended amounts will be applied to all ponds. Samples of water, fish, soil, and vegetation will be taken at 0,1,3,7,14, 28, and at each 28th day thereafter until no Dalapon can be detected or the amounts found are stabilized.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0115, PHOTOCHEMICAL METHODS FOR PURIFYING WATER

J.M. SMITH, Univ. of California, School of Engineering, ***Davis, California*** 95616

The primary objective is to evaluate photochemical processing as a means of tertiary water treatment. The first phase is to establish the most promising operating conditions (lamp-reactor geometry, residence time, light intensity, oxidizing agent, sensitizer, etc.) for a continuous flow process. These data would be obtained in a small, pilot-plant reactor, feed for which would be secondary effluents from Sacramento-area wastewater treatment plants. Preliminary runs with water from the Northeast Area Treatment Plant of the Sacramento County Sanitation District have indicated a reduction in COD of 25-50% without sensitizer of supplementary oxidant. When Fe ion was added as a sensitizer, the reduction was greater, but not markedly so. These initial results, admittedly not at optimum conditions, indicate that the photochemical method is a promising one. Of particular importance is the possibility of a process not using a sensitizer.

As a secondary objective, and with time permitting, studies would be made to evaluate photochemical decomposition as a process for removing resistant pesticides from water, especially wastewater.

1. PESTICIDE RESIDUES AND AQUATIC ENVIRONMENTS

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

1.0116, INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA

B.J. MECHALAS, Aerojet General Corporation, *El Monte, California* 91734 (14-12-539)

Description: This study has as its primary objective the establishment of a scientific basis from which meaningful recreational water quality criteria can be formulated. Ultimately, such criteria would be used as guidelines for setting recreational water quality standards. The health hazards faced by aquatic recreationists during primary contact activities (swimming, skindiving, etc.) in polluted water are being reviewed, analyzed, and mathematically related, with a view toward the construction of mathematical models which will correlate the variables involved in this epidemiological situation. A secondary objective is the delineation of informational gaps in our knowledge with respect to certain parameters needed to develop a rational basis for criteria formulation, and to suggest areas of needed research. The present investigation is restricted to a consideration of nine factors that represent the types of problems and parameters of importance in the development of recreational water quality criteria, namely, (1) total coliforms; (2) fecal coliforms, (3) salmonella, (4) viruses, (5) pesticides, (6) oils, (7) temperature, (8) pH, and (9) clarity.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0117, AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA

L.A. SCHINAZI, Aerojet General Corporation, *El Monte, California* 91734

This study has as its primary objective the establishment of a scientific basis from which meaningful recreational water quality criteria can be formulated. Ultimately, such criteria would be used as guidelines for setting recreational water quality standards. The health hazards faced by aquatic recreationists during primary contact activities (swimming, skindiving, etc.) in polluted water are being reviewed, analyzed, and mathematically related, with a view toward the construction of mathematical models which will correlate the variables involved in this epidemiological situation.

A secondary objective is the delineation of information gaps in our knowledge with respect to certain parameters needed to develop a rational basis for criteria formulation, and to suggest areas of needed research. The present investigation is restricted to a consideration of nine factors that represent the types of problems and parameters of importance in the development of recreational water quality criteria, namely, (1) total coliforms; (2) fecal coliforms, (3) salmonella, (4) viruses, (5) pesticides, (6) oils, (7) temperature, (8) pH, and (9) clarity.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0118, DEVELOPMENT OF TREATMENT PROCESS FOR CHLORINATED HYDROCARBON PESTICIDE MANUFACTURING AND PROCESSING WASTES

K.H. SWEENY, Aerojet General Corporation, *El Monte, California* 91734 (68-01-0083)

Description: To develop at the bench and pilot plant level a practical manufacturing waste treatment process for selected chlorinated hydrocarbon pesticides. The waste treatment process is based upon laboratory observation made during earlier work.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0119, ORGANIC SUBSTANCES IN WATER

D.F. GOERLITZ, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

Wide and complex varieties of organic substances are present in water and the number of the organic pollutants reaching water supplies is rapidly increasing. Knowledge of the extent, character, and composition of organic substances in water has lagged significantly behind that of the mineral components.

The work involves largely the development of methodology for the separation, identification, and measurement of organic substances in water. The initial work has been concerned with natural organic substances in water. The processes being developed basically involve extraction, vacuum evaporation, chromatography, and infrared spectroscopy.

The development of highly sensitive techniques for the separation, identification, and measurement of pesticides in water will be continued. Recovery studies will be continued and extended to cover additional pesticides to those already investigated. Efforts will also be directed toward the development of an electron capture gas chromatographic procedure for the analysis of chlorinated phenoxy acid herbicides and their derivatives in water.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

1.0120, ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS

D.H. PETERSON, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

Purpose: To increase our limited knowledge of the factors which control the abundance, distribution, and composition of organic matter in coastal waters and sediment.

Methods: 1) Determine the relative abundance, distribution and clay mineralogy of suspended sediment in San Francisco Bay waters in relation to source and waters, such as the distribution of saline water. 2) Survey the abundance and distribution of organic carbon in San Francisco Bay waters and sediment in relation to season, source and differences in depositional environment such as the distribution of NO3 and oxygen dissolved in the waters. 3) Study the distribution of specific trace elements in relation to the distribution of organic matter. 4) Survey the distribution of pesticides in sediment in relation to depositional environment and depth in sediment. 5) Study abundance and composition of organic matter thought to be of prime importance in the engineering properties of sediment. 6) Study the composition of selected geochemical constituents with depth in sediment in relation to source and subsequent alteration of organic matter.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

1.0121, STUDY OF ELECTROHYDRAULIC WATER TREATMENT

H. HOCHMAN, U.S. Navy, Civil Engineering Lab., *Port Hueneme, California*

Investigate the effect of electrohydraulic treatment on chemical species in water solution.

Approach: Conduct a feasibility study to determine the effect on electrohydraulic treatment on chemical compounds.

Dilute solutions of 3 chemicals--parathion, endrin and cetyltrimethylammonium bromide--were exposed to electrohydraulic treatment at the General Electric Company Experimental Plant at Alplans, New York. The treated solutions or their extracts were shipped to NCEL for analysis. The cetyltrimethylammonium bromide solution was analyzed photocolorimetrically and the parathion and endrin solutions were analyzed by gas chromatography. The results are reported in Technical Note N-1001, Effect of Electrohydraulics on Chemicals in Aqueous Solution, by H. Hockman, Dec 68. The findings were that electrohydraulics does destroy even dilute solutions of these organic compounds. The rate of destruction depends on the voltage and capacitance used, but is not related directly to the total power used.

SUPPORTED BY U.S. Dept. of Defense - Navy

1.0122, PREDICTING MINERAL QUALITY OF RETURN FLOW WATER

R.F. WILSON, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Flows from irrigation projects have been unduly criticized for the deterioration of the water quality in receiving waters. Much of the salt content of many river basins has been attributed to irrigation projects. Studies based upon the transmission and fate of agricultural chemicals including fertilizers and pesticides will be supported and coordinated with related studies being performed under other Reclamation activities and by other organizations. In order to differentiate the salt contribution from natural irrigation, municipal and industrial sources two catagories have been made under the main heading.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

1.0123, IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD

H.W. EDWARDS, Colorado State University, School of Engineering, *Fort Collins, Colorado* 80521

The major purpose of this proposed research is to develop and test an interdisciplinary mechanism for studying environmental contamination problems using a system approach. The purpose of the system approach is to provide the kind of broadly based information concerning the movement of a contaminant through the environment which will be useful in evaluating the nature and extent of a possible environment hazard. Examples of such contaminants include heavy metals such as lead and mercury, combustion-produced carcinogens, pesticides, etc.

The selection of lead for the model system offers several advantages in that it occurs in demonstrable amounts in the environment, has known deleterious health effects, and can be traced in its movement by newly-developed isotope-ration measurement techniques. The proposal has been well developed and the scientific staff is qualified to conduct the proposed research. Arrangements have been made for interactions between Colorado State University and other institutions interested in similar problems.

SUPPORTED BY U.S. National Science Foundation

1.0124, ATTENTION AND RUNOFF OF PESTICIDES FROM AGRICULTURAL LANDS TO SURFACE WATERS

G. BAILEY, U.S. Dept. of Agriculture, Agriculture Research Sciences, *Washington, District of Columbia*

Description: This agreement covers cooperative involvement in gathering data, information, evaluating, developing and verifying a Pesticide Runoff Mathematical Model, for better understanding the persistence and degradation of pesticides in soil.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0125, COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS

T.E. MALONEY, U.S. Dept. of the Interior, Bureau of Reclamation, *Washington, District of Columbia*

Description: The objectives of this project concern the determination of quantities, fate, and persistence of herbicides (including 2,4-D and acrolein) in irrigation systems for the purpose of ditchbank and submersed weed control. Amounts of herbicide getting into irrigation waters, remaining in the water as it is conducted to cropland, returning to drainage systems, and eventually returning to the mainstream will be studied. Determination's will also be made of amounts of herbicide absorbed by ditch bottom soil, aquatic vegetation, agricultural soils, and crop plants. Monitoring of major herbicides will provide significant data to support establishment of sound water quality criteria for use of herbicides in irrigation systems.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0126, EFFECTIVENESS OF IODINE FOR DISINFECTION OF PUBLIC WATER SUPPLIES & TO DETERMINE PHYSIOLOGICAL EFFECTS ON A HUMAN POPULATION

A.P. BLACK, Univ. of Florida, Graduate School, *Gainesville, Florida* 32601

This project is to demonstrate the effectiveness of iodine for the disinfection of polluted water supplies and to evaluate the several variables affecting such procedures to demonstrate the physiological effects, if any, on a significant number of consumers over an extended period of time. The water supplies of three state institutions will be disinfected with iodine and every sixth person of more than 600 inmates will be selected for intensive medical evaluation.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

1.0127, PESTICIDE KINETICS

C.W. MILLER, U.S. Dept. of Commerce, Natl. Oceanic & Atmos. Admin., *Gulf Breeze, Florida* 32561

Investigate, under field conditions, the occurrence and distribution of insecticides in tidal areas associated with an estuary. Samples of water, soil and selected biota will be collected immediately prior to application of the test material to establish a base line indicative of previous commercial treatments. The persistence, localization and possible degradation of the test chemicals will be followed.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0128, ESTUARINE ECOSYSTEMS

G.E. WALSH, U.S. Dept. of Commerce, Natl. Oceanic & Atmos. Admin., *Gulf Breeze, Florida* 32561

The purpose of this research is to determine effects of sublethal concentrations of pesticides upon estuarine ecosystems. At present, physical, chemical and biological characteristics of four very similar coastal ponds are being analyzed to learn normal seasonal variations. When these are known, three of the ponds will be treated with pesticide and one will be utilized as a control. Effects of pesticide upon population dynamics and community structures will be studied after contamination.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0129, CHEMICAL ANALYSES

A.J. WILSON, U.S. Dept. of Commerce, Natl. Oceanic & Atmos. Admin., *Gulf Breeze, Florida* 32561

In order to evaluate data now being obtained by a nationwide surveillance of organochlorine pesticide pollution in estuaries, studies are in progress to determine rates of uptake and the metabolism of these pollutants in marine species.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0130, EFFLUENT INFLUENCES OF THE MISSISSIPPI RIVER ON THE CHEMISTRY AND BIOLOGY OF ADJACENT OCEAN SYSTEMS

E.F. CORCORAN, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149

This grant supports investigations of the spectrum of the chlorinated-hydrocarbon pesticides in the water, particulate matter and sediments in the discharge of the Mississippi River into the Gulf of Mexico. The samples analyzed are from transects up the Mississippi River itself, other stations in the river plume and inshore regions of the Gulf of Mexico. Data from these investigations will indicate the extent of influence of the outflow of the Mississippi River on the waters of the Gulf of Mexico as well as the degree and rate of pesticide contamination of the river and adjacent regions of the Gulf of Mexico.

SUPPORTED BY U.S. National Science Foundation

1.0131, ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT

B.F. TAYLOR, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149

Funds from this grant support investigations of the pathway and mechanisms of anaerobic metabolism and fission of the benzene nucleus in aromatic compounds by marine microorganisms. Growth studies with a pseudomonad which has this metabolic capacity are employed to test suspected intermediate metabolites and to produce intermediates labelled with 14C which can then be isolated and identified. Other experiments involve the isolation and culture of bacteria which are from anaerobic marine environments and swampy regions under marine influences, and which are of varying physiologcal types and grow anaerobically on substrates containing aromatic compounds. There is a constant flow into the sea of aromatic derivatives, from such substances as organic pesticides, lignins and tannins and the by-products of the metabolism of other organisms, and some of these must ultimately reside in anaerobic situations. A knowledge of the susceptibility of aromatic compounds to anaerobic degradation and of the metabolic mechanisms involved will further our understanding of marine environments and pollution.

SUPPORTED BY U.S. National Science Foundation

1.0132, ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN

H.J. TEAS, Univ. of Miami, School of Arts, *Miami, Florida* 33124

To study the basic ecological factors in peninsular Florida with particular emphasis on those concerned with the survival of man. This will cover: (1) remote sensing of environment including the use of image enhancement techniques to distinguish plant species and communities from aerial photography; the use of aerial photography as a source of ecological data; monitoring of thermal pollution damage from aerial photography; (2) assessment of factors involved in environmental degradation: concentration and cycling of DDT in a laboratory model ecosystem; pesticide runoff from winter vegetable growing fields; evaluation of factors that may be effective in pesticide removal from food chains.

It is planned that these studies will involve students in ecological monitoring and evaluation.

SUPPORTED BY U.S. Natl. Aero. & Space Adm.

1.0133, EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY

T.S. HOPKINS, Univ. of West Florida, Graduate School, *Pensacola, Florida*

The campus of The University of West Florida is located on the west side at the head of Escambia Bay, a commercially important estuary for the production of oysters, shrimp, and fish. Part of the drainage basin of this estuary, including an embayment or bayou and small stream lies on University property that has been dedicated as a natural conservation area and will remain undeveloped.

The Faculty of the Department of Biology and Marine Sciences plans to initiate a continuing study of this habitat to determine the ecological relationship. Concurrently, a similar habitat on the east side of the bay that is not protected from man's encroachment will be studied in comparative detail to determine the effects of pollution. It is anticipated that the program will serve as a training program for graduate students in the field of marine biology.

An initial 12-month program is proposed that has the following objectives: 1. A physical, chemical, and biological inventory of the two bayous adequate to provide an understanding of the resident plant and animal communities; and, 2. An analysis of migratory fauna and their 'input' into the ecosystem; and, 3. A periodic surveillance project will monitor the water, bottom deposits and biota for pesticide residues. (These are anticipated because of the routine use of these chemicals in the drainage basin).

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0134, UPPER ST. JOHNS RIVER BASIN WATER QUALITY, FLORIDA

D.A. GOOLSBY, U.S. Dept. of the Interior, Geological Survey, *Tallahassee, Florida* 32304

This research is part of the program of water resources investigations conducted by the U. S. Geological Survey in cooperation with State and local agencies in Florida and the Corps of Engineers.

Purpose: To determine the types and sources of contaminants in waters of the upper St. Johns River basin as an aid in evaluation of water management proposals.

Methods: Seasonal sampling, with concurrent measurement of discharge, is proposed for about 20 sites in the basin and specific conductivity profiles along main stream and tributaries run to determine sources of contamination. Field and laboratory determinations will be made and besides the customary determinations of common minerals will include dissolved oxygen, pH, nutrients, pesticides and trace elements.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

1.0135, RURAL RUNOFF CONTROL

D.W. HILL, U.S. Dept. of the Interior, Federal Water Quality Admin., *Athens, Georgia* 30601

This research is designed to evaluate the contribution of rural runoff to pesticide and primary nutrient concentrations found in natural watercourses. Many phenomena are being investigated in detail, such as: adsorption mechanisms, degrees of reversibility, thermodynamic parameters, and the nature of the ionic equilibria between the particulate phase and classes of pesticides. More general interrelationships will be studied in the field including such phenomena as types and amounts of agricultural chemicals carried in surface runoff, in solution or adsorbed on different materials in the particulate phase; those that are mobile in interflow, and an estimate of the total amount received in the watercourse from other than surface runoff. An overall computer program will be constructed to incorporate those relationships that appear amenable to calculation. In some cases the findings outlined above will be incorporated in detail whereas other relationships may be grossly simplified in an effort to emphasize those phenomena which are relatively important in contributing to water pollution by rural runoff and to de-emphasize those which are relatively insignificant. Control recommendations and methodology will result from this research.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

1.0136, DEVELOP EFFECTIVE TREATMENT METHODS FOR HARD PESTIDICIDES

UNKNOWN, U.S. Environ. Protection Agcy., Athens Laboratory, *Athens, Georgia* 30601

No summary has been provided to the Science Information Exchange.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0137, FLUORESCENT PROBES IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS FOR WATER POLLUTION

C.M. HIMEL, Univ. of Georgia, School of Agriculture, *Athens, Georgia* 30601

Description: The primary aim of this project is to develop the enzyme-probe method widely used in the study of enzyme reactions for the detection of organophosphorous and carbamate pesticides.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0138, RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS

M.T. HUISH, Univ. of Georgia, Agricultural Experiment Sta., *Athens, Georgia* 30601 (GEO00392)

OBJECTIVE: Study is to provide answers to problems of the relationship of pesticides and farm pond ecosystems.

APPROACH: Most of Georgia's farm ponds are constructed on piedmont clay or sand. These two major soil types will be employed in the experimental design which will test Dieldrin and Lindane. Known concentrations of the pesticides will be introduced into fiberglass containers and the resulting concentrations in the two soil types, of flowing and nonflowing water systems, as well as concentrations contained in fishes and plants will be determined by use of gas chromatographic methods.

PROGRESS: During the report period the results of the first phase of the project were compiled in the form of a PhD thesis, 'Magnitude and Distribution of Insecticide Residues in Artificial Ecosystems and in a Farm Pond', by Wendell Joseph Lorio. The study will continue with another student, and will consist of pesticide applications to additional series of aquatic systems. The previous work on this project consisted of applying two pesticides (Lindane and Dieldrin) to three series of aquatic systems each of which included twelve forty-liter containers having selected soils, aquatic plants and fish. Water was static in 50% of the systems and flowing in the others. The pesticides were introduced at concentrations sublethal to the fish used. Samples of each component of the systems (fish, plant, soil and water) were taken. These were then subjected to standard extractive techniques to recover the Lindane and Dieldrin residues. Gas chromatographic methods were employed.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0139, TOXAPHENE CONTAMINATION - ESTUARINE ECOLOGY

R.J. REIMOLD, Univ. of Georgia, Marine Institute, *Sapelo Island, Georgia* 31327

Recent pilot studies conducted by the University of Georgia Marine Institute revealed a potential pollution problem related to the release of toxaphene into estuarine waters and sediments. The data revealed toxaphene concentrations of approximately 1.07 ppm in the estuarine water and 4,700 ppm in sediments about one-quarter mile from the effluent outfall. The research work is designed to consider the extent (quantity and quality) of this work contaminant in the sediments, water and biota. Attention also is focused on the concentration process in the sediments and its potential relationship to biological and geochemical processes. Concern is also directed to the toxaphene concentration in the estuarine sediments related to biological or chemical degradation. Studies are also being conducted to look at the transportation of the contaminant through the estuaries, and methods of rendering the existing effluent and sediments nontoxic.

Field studies focus on the randomly selected collection sites in the potentially contaminated area compared with samples collected from an undisturbed and thoroughly studied salt marsh watershed adjacent to Sapelo Island, Georgia. This newly discovered site of pesticide concentration within the estuarine ecosystem will become a problem of great public concern with time. The research considered herein will attempt to identify the significance of toxaphene contamination in the total estuarine ecosystem and its potential roles of limitation of seafood production as well as changes induced on the estuary due to its potential toxic effects.

SUPPORTED BY Hercules Incorporated - Wilmington, Del.

1.0140, A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC

D.W. MENZEL, Skidaway Inst. of Oceanograph., *Savannah, Georgia* 31406

This project to identify the major problems of man's contamination of the oceans will be carried out in two parts: (1) Samples of the ocean environment including zooplankton, fishes (migratory and non-migratory), benthic organisms sediments, sea water, surface slicks, and airborne material will be analyzed for pollutants (heavy metals, transition metals, pesticides, and petroleum derived hydrocarbons). (2) Following completion of the above program, a study group will be convened in Woods Hole to discuss the results and to interpret them. The final product will be the planning document for a full-scale research program in the Environmental Quality of the North Atlantic Ocean. Skidaway Institute of Oceanography will have primary responsibility for analysis of benthic organisms, zooplankton and sediments for heavy metal concentration. The Institute will play a leading role in the Part II Study. Dr. Menzel will be responsible for the overall management of the program.

SUPPORTED BY U.S. National Science Foundation

1.0141, SOILS, PESTICIDES AND THE QUALITY OF WATER

G.C. LEWIS, Univ. of Idaho, Agricultural Experiment Sta., *Moscow, Idaho* 83843 (IDA00516)

OBJECTIVE: Identify and characterize the physical-chemical properties of the pesticide-soil-water system which are pertinent to pesticide transport through the soil in infiltrating water, and pesticide desorption from eroded soil into surface water. Identify the principal degradation products and determine the mechanisms and kinetics of pesticide transformations in soil-water systems.

APPROACH: Adsorption-desorption equilibria of organophosphate pesticides in relation to the chemical properties of soils will be studied. The effect of various soil constituents on the degradation of the pesticides will be investigated. Decomposition studies will be carried out in sterile and non-sterile soil systems; degradation rates and end products will be determined.

PROGRESS: The adsorption isotherm of Di-Syston onto a southern Idaho soil (Portneuf Silt Loam) was determined. An S-shaped isotherm was obtained. A gas chromatographic technique was developed to separate and detect Di-Syston and its related compounds. Di-Syston, Di-Syston sulfone, and Systox (both isomers) were separated and detected at one temperature setting, while Di-Syston sulfoxide, Systox sulfoxide (both isomers), monoethyl phosphate, and diethyl phosphate were separated and detected at a different temperature setting. With the development of separation techniques it was possible to follow the rate of degradation of Di-Syston and its metabolites in the soil and determine whether degradation products of significance were formed. The degradation of the Di-Syston in the Portneuf soil was found to follow first-order kinetics and 50% of the added amount was degraded in 6.5 days under the conditions of optimum moisture and temperature. The most notable metabolites were Di-Syston sulfone and sulfoxide. The sulfone persisted for over 69 days while the parent Di-Syston was negligible after about 32 days. This indicated that the breakdown of Di-Syston sulfone was probably the rate limiting step in the conversion of Di- Syston to nontoxic products. The presence and persistence of the sulfone may be quite significant as the sulfone is probably more toxic than its parent compound, Di-Syston. Thus, the total toxicity may not have decreased in direct proportion to Di-Syston disappearance.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0142, STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES

R.H. SULLIVAN, Amer. Public Works Assn., *Chicago, Illinois* 60637

Pollution of storm water in urban areas is a result of contact with features which can be controlled to some degree by man. This study is designed to identify the relative importance of features which may contribute to the pollution such as litter, air pollution, chemicals used for control of ice and snow, and pesticides. In addition operation and maintenance practices for combined sewer systems will be investigated to determine means of reducing pollution from overflow.

Public Works practices will be reviewed and procedures outlined which would affect a reduction in storm water pollution.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0143, PESTICIDE MONITORING PROGRAM LAKE MICHIGAN

B.J. LELAND, State Dept. of Pub. Instruct., *Springfield, Illinois* 62706

A pesticide monitoring project involving Lake Michigan and tributaries in Illinois is proposed as part of the Four State Enforcement Conference. The prime objective is to determine whether substantial amounts of persistent chlorinated hydrocarbon insecticides are reaching the Lake. A second objective is to evaluate present levels of residue in sediments and in organisms representing the aquatic food- chain.

Since herbivorous organisms within streams consume large quantities of periphyton and since persistent insecticides are cumulative, the levels found within periphyton (algae) to a large extent determine the levels found in organisms higher in the food chain. Fresh-water mussels may be useful detectors of slug discharges. They are practically immobile organisms which pump large volumes of water and feed upon the particulate matter. Minor changes as well as major changes within different sections of the stream would be revealed in body tissue of the clams. An evaluation of levels of insecticides found within sediments is part of the monitoring program. Insecticide analyses will be performed on the whole bodies of fish native to the location.

All sampling will be in the eastern portion of Lake County, Illinois and along the shore line of Lake Michigan in Lake County. Analyses will be made in the Diagnostic Laboratory of the Illinois Department of Public Health at Chicago.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0144, THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT

G. SPRUGEL, State Natural History Survey, *Urbana, Illinois* 61801

Description: 1. To conduct laboratory and field investigations with methoxychlor, diazinon, and furadan to analyze the long - and short - term subtle, direct, and chain reaction responses of these pesticides on the living and nonliving constituents of the aquatic environment. 2. To develop and improve analytical and biological techniques and methodology essential to investigations on the disposition and fate of pesticides in the aquatic environment.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0145, COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE

E.L. KNAKE, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-15-0364)

OBJECTIVE: Study plant response to herbicides; develop weed control systems adapted to the soils, crops and climate and specific weed problems of Illinois; develop weed control methods that will improve environmental quality for both desirable plants and humans.

APPROACH: Individual crop and weed response to herbicide placement in the soil will be studied. Since some weeds are more sensitive through shoot adsorption than root adsorption or vice versa, better control methods could result from studies on herbicide placement. New chemicals and chemical combinations will be evaluated for their performance in preplant, preemergence and postemergence weed control systems. Combinations of cropping systems, chemicals and cultivation will be used to develop control measures for nutsedge, climbing milkweed, common milkweed and wirestem muhly. Weed control methods will be developed that will minimize the potential for surface runoff of herbicides (minimum tillage) into water supplies.

PROGRESS: Greenhouse studies, to determine the extent to which morphological differences between plant species may serve as a basis for herbicide selectivity, will compare two grass species, Avena sativa with an elongating mesocotyl and Triticum vulgare without same. Field studies include the delineation of specific herbicide rates needed for control of specific weed species. Herbicide combinations with various ratios have been evaluated to improve consistency of performance and spectrum of control. Propachlor plus atrazine at 3 plus 1.6 lbs/A for surface application and butylate plus atrazine at 3 plus 1 lb/A preplant incorporated have been the two outstanding combinations for soil with 3 to 7 percent organic matter. Studies with low volume application equipment indicate feasibility for both liquid and wettable powder formulations. Calibration is more difficult than with conventional pressure systems. Evaluation of 13 granular formulations suggests considerable commercial potential for propachlor plus atrazine and alachlor plus atrazine. Use of herbicides for controlling vegetation in no-till systems indicates the feasibility of paraquat plus atrazine to kill fescue sod, but the need for translocated herbicides (2,4-D or dicamba) to control alfalfa.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0146, RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS

H.V. LELAND, Univ. of Illinois, School of Engineering, *Urbana, Illinois* 61801

The objective of this study is to evaluate ecological effects associated with the use of several insecticides currently recommended as suitable replacements for the more persistent chlorinated hydrocarbon compounds. The degree of persistence and biological concentration of selected organophosphate and carbamate residues in water will be determined at experimental inpoundments. Known amounts of insecticides will be applied under normal operating conditions at prescibed application rates. The toxicity of stable residues to vertebrate and invertebrate aquatic species will be determined by continuous-flow bioassays. Pathways of degradation and persistence of metabolites in these species will be examined using radiolabelled insecticides. Heterocylic compounds are ring-labelled to permit concurrent evaluations of the pathways of metabolism of the insecticide and the stable products of hydrolysis. This project will assist in the development of sound practices relating to the use of insecticides near lakes and streams and will assist in the establishment of water quality criteria for these insecticides.

SUPPORTED BY U.S. National Science Foundation

1.0147, GREAT LAKES PESTICIDE MONITORING PROGRAM, INDIANA

L.R. CARTER, State Board of Health, *Indianapolis, Indiana* 46207

Description: To determine the amount of pesticide usage, the concentrations of pesticides in receiving waters, and fish and other aquatic life.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0148, THE FACTOR CONTROLLING THE DYNAMICS OF NON-IONIC SYNTHETIC ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS

J.L. HAMELINK, Purdue University, School of Agriculture, *Lafayette, Indiana* 47907

Project objectives include: 1) Evaluation of non-ionic synthetic organic chemicals (NISOC) to intact and suspended lake sediments in water; 2) Evaluation of the desorption of NISOC's from intact and suspended lake sediments into water; 3) Evaluation of the influence of increasing organic matter content in the sediments has on persistence and recycling of NISOC's; 4) Evaluation of the influence of increasing organic matter content in the water has on persistence, biological magnification and recycling of NISOC's in lentic environments; 5) Initiate development of an evaluation procedure to be used for defining water quality standards governing NISOC's; 6) Development of economically feasible practices or treatments to reduce NISOC residue levels in contaminated lentic environments; and 7) Evaluation and comparison of the persistence of brominated and chlorinated NISOC's in lentic environments.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0149, LIMNOLOGICAL FACTORS AFFECTING PESTICIDE RESIDUES IN SURFACE WATERS

D.B. MCDONALD, Univ. of Iowa, School of Engineering, *Iowa City, Iowa* 52240

Studies will be conducted to determine the relationship between runoff, plankton blooms and other chemical and biological factors on the concentration of various chlorinated hydrocarbon pesticides in the Coralville Reservoir and Iowa River, Iowa.

Additional studies will be conducted to determine the role of various aquatic organisms in the uptake and concentration of these pesticides.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0150, PESTICIDE RESIDUES IN KANSAS STREAMS

R. HARTMANN, State Forest. Fish & Game Com., *Pratt, Kansas* 67124

PS Objective: To determine the extent of accumulation of chlorinated pesticide residues present in some organisms and substrata of Kansas streams.

Procedures: 1) Eight primary and 11 secondary pesticide sampling sites will be established. The primary stations will sample over 90 percent of the drainage area of the state. The secondary sites will provide additional information on potential sources of pesticide contamination. 2) All sites will be sampled twice yearly for two years. Sampling periods will be May 1 to June 15 and August 10 to September 10. Fish collected in late April and May 1971, in conjunction with a mercury study (state activity) have been stored and will constitute the Spring 1971 sample for the present study. Most samples for the mercury testing were taken from sites chosen for this study. 3.) The following specimens will be collected: a) A composite sample of five adult, uniform size carp. b) A composite sample of five adult, uniform size channel catfish. c) A composite sample of five other pisciverous fish will be collected if either carp or catfish are not obtainable. d) A composite sample of five large bivalves. e) A one-quart sample of bottom mud. f) A 500 ml water sample, mixed with 25 ml 2,2,4-trimethyl pentane, will be stored pending analysis of other samples. 4) All fish will be collected by netting or shocking; composite sample size will not exceed 15 pounds. Bottom samples will be obtained with an Ekman dudge. Bivalve collection methodology will be determined by the collection at the site. 5) Fish samples will be weighed, measured and scales or spines collected for age determination. Composite groups will be wrapped in aluminum foil, labeled and frozen as rapidly as possible. 5) Standard laboratory techniques (principally gas chromotography) will be used to determine residual levels of DDT, DDE, DDD, Aldrin, Dieldrin, Endrin, Heptachlor, Epoxide, Toxaphene, Chlordane, Lindane, BHC, and PCB's in the chlorinated hydrocarbon groups and silves, 2,4,D and 2,4,5-T phenoxy herbicides.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0151, DETECTION AND IDENTIFICATION OF MOLECULAR WATER POLLUTANTS BY LASER RAMAN SPECTROSCOPY

E.B. BRADLEY, Univ. of Kentucky, Water Resources Institute, *Lexington, Kentucky* 40506

The proposed research is a study of the application of laser Raman spectroscopy in the detection and identification of molecular water pollutants. The primary advantages in such an approach are (1) laser Raman spectroscopy offers a direct method of detection and identification of molecules in water solution or suspension, and (2) the ability to detect and identify high-molecular-weight pollutants.

Laboratory and field investigations will include the following: (a) preparation of standard samples of various industrial and agricultural molecular water pollutants to which Raman spectroscopy is uniquely applicable, (b) use to standard samples to establish levels of detectability, sensitivity limits, and numbers of compounds in representative polluted water samples from industrial effluents that can feasibly be detected and identified by laser Raman spectroscopy at one time without separation techniques, (c) construction and testing of internal-beam-condensing cells, multiple-entrance cells, and laser- cavity cells, (d) sensititivity enhancement of Raman spectra by beam ratioing, (e) development of a catalog of standardized Raman spectra of a wide variety of water-soluble industrial waste products divided into the following categories: 1. organic pesticides, 2. petroleum products, 3. detergents, 4. inorganics.

The data will be employed to develop practical applications of laser Raman spectroscopy for the extension of analytical techniques of molecular identification outside the normal capability of GLC and mass spectroscopy.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0152, GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA

T.E. SHELLENBERGER, Gulf South Research Institute, *Baton Rouge, Louisiana*

A pesticides monitoring program will be established in order to determine the environmental occurrence and levels of various pesticides in the Barataria Bay-Mississippi Delta region. Results of this study are necessary to assess the effects of man on the environment since many pesticides may be detrimental to the reproduction and survival of some species and excess pesticide residues in commercial species may be hazardous to man.

Samples consisting of water, mud, invertebrate filter feeders, crab, and a predator fish will be obtained periodically from 10-20 samples sites for subsequent residue analysis using gas-liquid chromatographic techniques. Analysis for organochlorine pesticides will be emphasized initially since these materials are generally more stable in the environment and more apt to be seen in samples of these study.

SUPPORTED BY U.S. National Science Foundation

1.0153, ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS

G.G. GUILBAULT, Louisiana State University, Graduate School, *New Orleans, Louisiana* 70122

Research will be conducted on (1) the use of enzymes systems for determination of inorganic and organic pollutants in saline water and (2) purification of water by selective enzymatic degradation of toxic materials. The approach involves the investigation by means of electrical and fluorimetric techniques, of a number of enzyme systems for analysis of impurities such as heavy metals, hydrocarbons, phenols and pesticides. In another phase of the work, the efficiency of enzymatic conversion of amines, acids, alcohols and hydrocarbons will be investigated.

SUPPORTED BY U.S. Dept. of Interior - Off. Saline Water

1.0154, POLLUTION LOADS IN RUNOFF FROM SMALL AGRICULTURAL WATERSHEDS

W.F. SCHWIESOW, Univ. of Maryland, School of Agriculture, *College Park, Maryland* 20742

A gaging station and automatic sampler are to be installed at the discharge point of a small agricultural watershed. The watershed to be selected should be between two and twenty acres in size. A larger area may be used if other factors make it impossible to locate a suitable watershed having less than twenty acres. Flow rate and volume will be determined by use of a weir type gaging station. Samples will be drawn at three different elevations by use of a float regulated sampling pipe. Samples will be pumped into containers that are stored within a refrigerator located at the gaging station. Analyses will be made to determine the quantity of major plant nutrients and selected pesticides and herbicides in the runoff water.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0155, EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS

T.H. FENG, Univ. of Massachusetts, School of Engineering, *Amherst, Massachusetts* 01002 (DA-49-193-MD-3036)

Objective: To investigate (a) the effect of chemical impurities on the bactericidal activities of halogens in aqueous solutions and (b) the odor and taste produced in the process of halogenation.

Approach - Calcium, Iron, Phosphate, and one surface active agent will be the chemical impurities to be investigated in the initial phase of the study. E. coli will be used as the test organisms. Temperature will be maintained at 25 degrees C, and pH controlled at 5, 7, and 9. Halogens to be used will be chlorine, bromine and iodine. Odor and taste determinations will be made in parallel with the disinfection experiments.

Progress - During this period studies have been of a fourfold nature. In the first place the disinfection efficacy of free chlorine residual alone in water has been established in connection with exposure conditions of temperature, contact time, dosages and pH which would afford reproducible and significant experimentation with chemical additives. Secondly, similar experiments have been initiated with free bromine residual. Thirdly, the effects of calcium bicarbonate on the disinfection efficacy of free chlorine residual have been investigated. Lastly the taste threshold concentration of free chlorine residual in water at pH 5.0, 7.0 and 9.0 has been studied. The basic depth kinetics of escherichia coli under specified conditions using free chlorine residual, and to a lesser extent free bromine residual, as the disinfectants, have been established. Calcium bicarbonate, at a concentration of 610 milligrams per liter as calcium carbonate, was found to affect the bacterial cell resistance to, and the disinfecting properties of free chlorine residual in the destruction of E. coli cells.

SUPPORTED BY U.S. Dept. of Defense - Army

1.0156, PESTICIDE MONITORING PROGRAM

R.A. ISAAC, State Div. of Fisheries & Game, *Westboro, Massachusetts*

This project will investigate pesticide monitoring techniques and demonstrate for the benefit of division personnel the use of specialized analytical methods for determination of hydrocarbon concentration in the aquatic environment.

Specifically the project will: (1) Continue an on-going monitoring program (on a reduced scale) for the major watersheds of the Commonwealth. (2) Investigate the use of fresh-water mussels as indicator organisms. (3) Investigate the use of carbon adsorption columns at automatic monitoring stations. (4) Demonstrate use of gas chromatography and infrared spectrophotometry.

SUPPORTED BY Massachusetts State Government

1.0157, MASSACHUSETTS PESTICIDE MONITORING STUDY

W.A. TOMPKINS, State Div. of Fisheries & Game, *Westboro, Massachusetts*

The objective of the project is to define the pesticide pollutants on the major watersheds of the State of Massachusetts through the operation of 100 monitoring stations which will sample aquatic organisms for pesticide residues.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0158, A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC

V.T. BOWEN, Woods Hole Oceanographic Inst., *Woods Hole, Massachusetts* 02543

This project to identify the major problems of man's contamination of the oceans will be carried out in two parts; (1) Samples of the ocean environment including zooplankton, fishes (migratory and non- migratory), benthic organisms sediments, sea water, surface slicks, and airborne material will be analyzed for pollutants (heavy metals, transition metals, pesticides, and petroleum derived hydrocarbons). (2) Following completion of the above program, a study group will be convened in Woods Hole to discuss the results and to interpret them. The final product will be the planning document for a full-scale research program in the Environmental Quality of the North Atlantic Ocean. Woods Hole Oceanographic Institution will provide the large ship sampling effort; chemical analyses of pesticides and petroleum derived hydrocarbons; will ensure intercalibration of the United States and United Kingdom laboratories; and will host the study group responsible for interpreting the results of the baseline study and recommending a course of action for Environmental Quality research in the North Atlantic.

SUPPORTED BY U.S. National Science Foundation

1.0159, ADSORPTION OF PESTICIDES FROM SEA WATER

G.R. HARVEY, Woods Hole Oceanographic Inst., *Woods Hole, Massachusetts* 02543

The proposed work involves adsorption of the dissolved organic carbon, including chlorinated hydrocarbon pesticides, from sea water onto a cross-linked polystyrene resin (XAD-4) followed by desorption with an organic solvent. Optimum flow rates, etc. will be determined. The parameters of pH, temperature and salinity will be related to the pesticide adsorption process. If necessary, large volumes of sea water can be examined conveniently in this manner by in situ pumping of the water through the resin. A further advantage of this method is that it will allow sufficient organic material to be collected so that positive identification by spectroscopy will be possible. Also, small losses occurring during concentration and transfers will have minimal effects on the final calculations.

We intend to test this analytical technique for pesticide monitoring in salt ponds and cranberry bog effluents.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0160, MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES

R. REINERT, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Ann Arbor, Michigan* 48107

A monitoring program to measure levels of insecticides in various species of fishes and water from each of the five Great Lakes.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0161, AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION

R.C. BALL, Michigan State University, Institute of Water Research, *East Lansing, Michigan* 48823

The objectives of the research are (1) to develop indicator indices from analyses of structure and function of selected stream communities for predicting the short term and long term significance of gradual degradation of water quality by human accelerated eutrophication, (2) to obtain sufficient baseline data on water quality and associated community responses in streams on watersheds having different degrees of agricultural and urban drainage to allow for development of systems analysis of aquatic ecosystems, (3) to evaluate the effects of urbanization on stream discharge and concurrently, the relationship of stream stability to the structure of aquatic communities, and (4) to accomplish the preliminary work for developing adequate techniques for quantifying the esthetic and recreational value of a stream and public attitudes toward competing demands on the resource.

Three watersheds on the Lower Peninsula of Michigan have been selected for exhibiting a graded series in degree of eutrophication and urbanization. Four intensive study sites, consisting of from 100 to several hundred meters of contiguous stream, have been located in these watersheds at points where severe, moderate, slight and minimal eutrophication is occurring. The ecosystems of the intensive study sites will be investigated through analyses of (1) community structure, (2) community metabolism, (3) indicators of impending degradation, and (4) water quality. Data concerning these ecosystems will be interpreted in a background of information gathered from the watersheds concerning (1) nitrogen and phosphorus enrichment, (2) pesticide contamination, (3) heavy metal concentrations, (4) stream stability and urbanization, and (5) socioeconomic aspects of stream degradation.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0162, WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN

M.E. STEPHENSON, Michigan State University, School of Engineering, *East Lansing, Michigan* 48823

The objectives of the project are to (1) establish a storage and retrieval system of data on water quality and quantity within the surface system of lakes and streams of a major watershed of Lake Michigan, the Grand River, and (2) collect and collate existing data pertaining to the physical, chemical, biological, and socio-economic aspects of the water resources of the basin, (3) incorporate a current evaluation of material transport (phosphorus, nitrogen, total carbon, pesticides, etc.) within the river system, (4) determine the qualitative and quantitative relationships between waste discharge and receiving stream water quality on the Grand River system and Lake Michigan, and (5) carry out a compilation and analysis of land use practices and socio-economic developments as related to each of the water resource parameters considered above.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0163, PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN

C.M. FETTEROLF, State Bur. of Water Management, *Lansing, Michigan* 48926

Insecticides have been identified as causing problems with reproduction of gulls and raptorial birds in the Michigan portion of the Great Lakes Basin, as well as causing reduction hatchery reproductive success of coho salmon, and by accumulating above FDA tolerances in fish. Objective of this program is to identify the levels of pesticides in tributary streams to the Great Lakes from the State of Michigan, to identify the sources so they may be controlled, and to establish residue backgrounds against which to judge the success of control programs.

Water samples are collected monthly from the mouths of major tributaries to the Michigan portions of the Great Lakes and analyzed by gas chromatography for several insecticides. Freshwater mussels are held in cages for 3-4 week periods near the mouths in the major tributaries and in 60 minor tributaries and then analyzed for several insecticides. This exposure period permits them to accumulate insecticides to measurable concentrations. Stream sediments are also analyzed periodically. As major pesticide-contributing water courses are identified, sampling fans out into the interior to the sources.

Spot sampling is conducted at municipal and industrial wastewater sources and in addition municipal water supplies are checked periodically. Similar programs are underway in Ill., Ind., Minn., and Wisc.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0164, PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN

C.M. FETTEROLF, State Dept. of Nat. Resources, *Lansing, Michigan* 48926

Description: To identify the levels of pesticides in tributary streams to the Great Lakes, to identify the sources so they may be controlled, and to establish residue backgrounds against which to judge the success of our control programs.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0165, PESTICIDE TESTING FOR SETTING STANDARDS

UNKNOWN, U.S. Environ. Protection Agcy., Duluth Laboratory, *Duluth, Minnesota* 55804

No summary has been provided to the Science Information Exchange.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0166, PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN

T.A. OLSON, State Pollution Control Agency, *Minneapolis, Minnesota*

Description: The Upper Lakes Governors' Conference on Pesticides in April 1969 stated the recommendations of the Lake Michigan Enforcement Conference were to be immediately and fully implemented as well as expanded to include the Minnesota and Wisconsin drainage basin of Lake Superior and the Michigan drainage basin of Lakes Superior and Huron. The Minnesota portion of the program will follow the following plan of operation: 1. Fish samples will be taken three times a year (spring, summer and fall) for pesticide analysis at three selected locations in the lake by the Conservation Department and local commercial fisherman. Special sampling of both indigenous and anadromous fishes will be conducted in tributary streams. 2. Water samples will be taken monthly at the Duluth and Grand Marais water intakes and mouths of the St. Louis, Beaver, Knife and Brule Rivers. Samples of the Duluth sewage treatment plants effluent will also be taken. Water samples from the four above tributaries and the Duluth STP will be taken by continuous sampling over a three-day period. 3. The use of freshwater clams as biological filters seems to be the logical answer to monitoring pesticide levels in the smaller tributaries and they will be incorporated into the monitoring program.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0167, PRESTICIDE INPUTS AND LEVELS IN MINNESOTA WATERS OF THE LAKE SUPERIOR BASIN

T.A. OLSON, Univ. of Minnesota, School of Public Health, *Minneapolis, Minnesota* 55455

The continued use of persistent insecticides in the Great Lakes System constitutes a potential threat to that Ecosystem and ultimately to the welfare and well-being of man. One of the first steps which must be taken if this hazard is to be met and brought under control is the accurate identification of the sources and avenues of entry which characterize each pesticide. The proposed study of Minnesota Waters of Lake Superior will therefore deal with current pesticide levels in streams along the North Shore of Lake Superior and is designed to determine the importance of these streams and their respective watersheds as sources of insecticide pollution. Captive, living fresh- water clams or other suitable organisms, which can take up and store insecticides, will be employed as concentrators in certain streams. A Water monitoring program which complements the test with living organisms, will be directed toward the major tributaries and will consist of samples collected on a scheduled basis, in some instances over a three day period. The north shore area, with its streams, from Duluth to the Canadian boundary, is to be included in the study.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0168, A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES

L.K. CUTKOMP, Univ. of Minnesota, School of Agriculture, *Saint Paul, Minnesota* 55101

The objective is to determine whether the sensitivity of the ATPase enzyme system in fish can be used to measure toxicity or adverse effects of chlorinated hydrocarbon insecticides in pesticide-polluted waters.

ATPase enzymes have been shown to be sensitive to DDT and related chemicals, with some metabolites, such as DDA, having virtually no effect.

Other chlorinated hydrocarbons, the cyclodienes, also affect the enzyme system, but in a way which is usually distinguishable from DDT inhibition. Organophosphate and carbamate insecticides have not been found to effect ATPase significantly.

A secondary objective is to determine which tissues and subcellular fractions are the most sensitive to the compounds. Tissues being studied are brain, muscle, liver, and kidney. Because DDT, in particular, shows some different activity due to temperature, this aspect is also being studied.

Assays for enzyme activity are being carried out on the bluegill fish and studies will continue on this species which is sensitive to the insecticides, easily reared and collected, and occurs in rather diverse aquatic environments.

Acute and chronic exposure of the fish will be employed to relate to the findings of inhibition of the enzyme system.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

1.0169, MAYFLY DISTRIBUTION AS A WATER QUALITY INDEX

C.R. FREMLING, Winona State College, Undergraduate, *Winona, Minnesota* 55987

Description: Adult mayflies are being collected systematically along the entire Mississippi River. An efficient, reliable, large-scale collection system was initiated in 1957 and is in continuous operation. Past and future collections will be analyzed to determine: (1) geographical distribution of the various species, (2) times of adult emergence, (3) area of scarcity and abundance, (4) population trends. Most important, these analyses will determine the present state of the river as habitat for pollution-sensitive organisms. These data will provide a basis for comparison, should the quality of the aquatic habitat change in the future. The degree to which burrowing mayflies contribute to total tubidity and to coliform bacteria levels will be determined.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0170, PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS

L.L. MCDOWELL, U.S. Dept. of Agriculture, Sedimentation Laboratory, *Oxford, Mississippi* 38655 (SWCW1-BE-4)

OBJECTIVE: Extend knowledge of the deleterious and beneficial physical and chemical attributes of sediments in runoff waters, in channel deposits, and in impoundments.

APPROACH: Obtain sediment samples for analysis and evaluation at selected sites in the Lower Mississippi River and some principal tributaries, in selected channels draining agricultural lands, and in selected reservoirs and impoundments. Factors involved include dispersion and flocculation tendencies, exposure to air and sunlight, water depths in reservoirs, age and depth of submerged sediments, and other environments.

PROGRESS: Analyses for pesticides content of streambed samples of the Lower Mississippi River and many of its tributaries taken during 1966 and 1967 generally confirm the findings from the 1967 sampling and reported in the American Society of Agronomy Special Publication No. 8, November 1966. Many of the samples obtained near a manufacturing plant for endrin and heptachlor, or near the plants of formulators, had measurable amounts of dieldrin, aldrin, endrin, isodrin, X, Y, chlordane, lindane, and DDT analogs and metabolites. On the other hand, with only one exception, DDT analogs and metabolites were the only pesticide residues found that originated from nonindustrial sources, i.e., municipal and agricultural; and many of these residues were found at concentrations less that 0.05 ppm. Of 125 samples collected in 1966 from tributary streams in Mississippi, Arkansas, and Louisiana, half had no measurable pesticides, a third contained measurable DDT or its associates only, and a sixth had additional pesticides. Improvements in analysis techniques have resulted in the detection of chemicals not previously found, and in the detection of all at lower levels of concentration. But, the principal conclusion of the 1964 sampling program still holds. That is, that the large quantities of pesticides previously applied to crops in the Mississippi Delta have not created widespread, detectable contamination of streambed materials. This is not to say that no contamination was found.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0171, DEVELOP IN-HOUSE CAPABILITY IN WATER QUALITY TECHNIQUES FOR ANALYSES OF HEAVY METALS, BACTERIA, AND PESTICIDE RESIDUES

C.F. DERRINGTON, U.S. Army, Corps of Engineers, *Vicksburg, Mississippi*

Technical Objective: The purpose of this program is to develop an in-house capability for analyzing water samples and related materials for pollutants such as heavy metals, bacteria, and pesticides. Optimum parameters will be developed or determined for the analysis of these pollutants. The program will provide the U. S. Army Corps of Engineers with the badly needed capability of analyzing water samples to determine what pollutants are present and their respective concentrations.

SUPPORTED BY U.S. Dept. of Defense - Army

1.0172, SERVICES FOR THE QUANTITATIVE ANALYSIS OF PESTICIDES IN SEAWATER AND BIOLOGICAL SAMPLES

J.P. USSARY, Analytical Biochemistry Labs., *Columbia, Missouri* (68-01-0122)

Description: The purpose of this contract is to determine the performance of quantitative analyses of certain pesticides in seawater and in biological materials. This effort is in support of a developing program in the definition of water quality criteria in marine systems.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0173, DEVELOPMENT OF FIELD METHODS IN SAMPLING WATER FOR PESTICIDE ANALYSIS

D.L. STALLING, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The use of plastic films, gel permeation materials (LH-20), and immobilized liquid phases to separate and concentrate low levels of pesticides from water will be studied. Polyethylene films and solvent filled plastic bags have demonstrated an ability to concentrate organochlorine pesticides from dilute water solutions. Various types of plastics will be evaluated. Concentration ratios, equilibration times, and uptake rates will be compared. Concentration of pesticides by partition using water flow through immobilized liquid phases and organic gel permeation resins show promise as simple sampling methods. Extraction with solvents denser than water will also simplify separation of pesticide from water.

Definition of the selectivity and general applicability of each approach will be important factors in selecting techniques for field use.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0174, PREPARATION OF CHLORINE-36 LABELED ORGANOCHLORINE PESTICIDES AND RELATED COMPOUNDS (PCB'S)

D.L. STALLING, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The use of radio-labeled materials greatly facilitates the determination of residue levels in acquatic organisms resulting from exposure to chlorinated pesticides or other multiple component materials such as polychlorinated biphenyls. Non-radioactive chlorinated materials will be exposed to a flux of thermal neutrons to produce radioactive chlorine-36 labeled compounds. Other short-lived byproducts will be allowed to decay and impurities resulting from radiation damage will be removed by chromatography.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0175, DEVELOPMENT OF ANALYTICAL METHODS FOR SELECTED HERBICIDES

R.C. TINDLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The purpose of this work unit is to survey the literature for possible methods for use with selected herbicides; and to evaluate any method which seems to show promise. The evaluation process will also include the development of modifications when necessary. Radioactive pesticides will be used when available.

When possible, GLC will be used for the analytical determination, and, consequently, it will be necessary to form derivatives of some of the compounds. Possible derivatives will be prepared on the macro scale for evaluation and for direct preparation of standard solutions.

Reports will be in the form of stepwise procedures for inclusion in the Residue Analysis Handbook. In addition, if the developed method represents a sufficiently new technique, a manuscript for publication will be prepared.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0176, UPDATING THE 'HANDBOOK OF PROCEDURES FOR PESTICIDE RESIDUE ANALYSIS' - METHODOLOGY IN CHEMICAL ANALYSIS AND SAMPLING

R.C. TINDLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objective of this work unit is to bring together any material necessary to update the existing 'Handbook'. Periodic updating is necessary so that the 'Handbook' will reflect the current 'state-of-the- art' in residue analysis. The report for this work unit will consist of a supplement to the handbook which should be ready for review in late fall 1971.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0177, THE EFFECTS OF HERBICIDES, PESTICIDES, AND FERTILIZERS ON THE OPTICAL PROPERTIES OF WATER

M.R. QUERRY, Univ. of Missouri, Water Resources Research Ctr., *Columbia, Missouri* 65201

A study is proposed to determine the effects of herbicides, pesticides, and fertilizers on water's capacity to reflect and absorb electromagnetic radiant flux.

The objectives of the project are: (1) The measurement of the reflectance and transmittance of water solutions of herbicides, pesticides and fertilizers with infrared radiant flux. (2) The computation of the optical constants, i.e. the index of refraction and the extinction coefficient from the reflectance and transmittance data. (3) The computation of the absorptance and reflectance of radiant energy for these solutions, and to relate these results to possible long range changes in the thermodynamic equilibrium of rivers, lakes, and coastal waters. (4) The further study of the intermolecular interaction of solutes with the water substance.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0178, LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION

G.E. SMITH, Univ. of Missouri, School of Agriculture, *Columbia, Missouri* 65201

Description: This study proposes to analyze the runoff and sediments removed from 31 soil erosion plots (on midwest claypan research farm, near McCredie, Missouri). Variables are, rates of fertilizer application (nitrogen and phosphorus), pesticides, tillage practices and cropping systems.

This study will make analyses of the runoff water and sediments and will determine the amount of nutrients and pesticides lost to surface water and penetrating through the soil profile. Studies will also be made of the nitrogen and phosphate contents of water entering three reservoirs in farming areas. Analyses of water samples will show retention in the reservoir and the quantity that eventually enters streams below the impoundments.

Soils differ widely in properties. These results will provide accurate information on the effects and fate of fertilizers and pesticides applied to claypan soils that represent about 5 million acres of cropland in the mid-continent states. This type of information on a number of soil types is essential before an accurate assessment of different farm practices on water pollution can be made.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0179, FERTILIZERS AND SEDIMENTS AS WATER POLLUTANTS

G.E. SMITH, Univ. of Missouri, Agricultural Experiment Sta., *Columbia, Missouri* 65201 (MO-00376)

OBJECTIVE: Determine fate of nitrogen and phosphate fertilizers, (and sediment) from the major soils of Missouri under clean cultivation and vegetative cover. Make analyses for nitrogen and phosphorus compounds in the runoff and sediment from erosion plots-McCredie Station.

APPROACH: Nitrogen and phosphate fertilizers will be applied to major soils of the state. A rainfall simulator will apply precipitation to plot areas. Analyses of runoff, sediment and soil cores (untreated soil, and collected 24 hours and one year after water application) will show the fate of N and P. New studies are being initiated on the erosion plots at the McCredie Station by USDA-ARS where tillage, fertilizer treatments and cropping systems are variables. Laboratory analyses will be made of the runoff and sediment for nitrogen, phosphorus and pesticides compounds.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0180, RAPID DETECTION OF TOXIC MATERIALS IN WATER

L. GOODSON, Midwest Research Institute, *Kansas City, Missouri* 64110

Description: To design, develop, fabricate, demonstrate and evaluate an automatic water monitoring device which will provide a warning signal in response to the presence of organophosphates in watercourses.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0181, SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS

J.C. HUANG, Univ. of Missouri, School of Engineering, *Rolla, Missouri* 65401

The purpose of this research project is to investigate the sorption and desorption reactions of selected chlorinated hydrocarbon pesticides with clay minerals in laboratory-controlled environmental systems. Particular emphasis will be placed on ascertaining the effect of organic matter on the behavior of sorption and desorption and determining the influence exerted by selected other environmental stresses, including pH, temperature and salt concentration of the water.

Pesticide selected for this study include DDT, dieldrin and heptachlor, and clay minerals selected are kaolinite, montmorillonite and illite. Laboratory investigations will include the following studies: (a) Batch and column studies to evaluate the effect of organic matter on the sorption and desorption reactions, and (b) Aquatic model studies conducted under rigidly controlled conditions to ascertain the effect of other environmental factors on the sorption and desorption reactions.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0182, GROUND AND SURFACE WATERS - POLLUTION

A.J. KAPLOVSKY, Princeton University, Agricultural Experiment Sta., *Princeton, New Jersey* 08540 (NJ00527)

OBJECTIVE: Development of analytical methods for detecting pesticides, herbicides and phenols in water; determine presence and morphological, cultural, physiological and chemical characteristics of populations of bacteria in polluted waters; environmental factors affecting bacterial pollution of well waters and stream self- purification; factors affecting efficiency of septic tank operations.

APPROACH: Current analytical methods will be modified, tested and used in analyses of representative samples of potable waters. Model systems will be developed for laboratory studies of bacteria appearing in polluted water. Effectiveness of various diatomaceous materials for removing bacteria from polluted water will be evaluated in relation to flow. The relative rates of oxidation of organic particles of varying sizes will be determined. Septic tank efficiency work will relate effluent characteristics to soil characteristics.

PROGRESS: Runoff from crop raising areas was primary source of nutrients in sufficient concentration to cause eutrophication. Drainage from pastures contributed to nutrient level but significant source of pollution from area was coliforms. 'Straight-line' or linear estuary built in control temperature room which permits concentrating upon biological parameters of estuary. Will demonstrate the predictability of nitrification in estuarine waters. Simple, sensitive and rapid procedure was developed for separation and identification of extremely low concentrations of halogenated phenols in water. Procedure involves conversion of phenols into corresponding antipyryl or p-nitrophenyl azo derivatives. The rate and extent of oxygen uptakes of stream waters representing various land usages were determined. Role of nutrients, nitrification, and sedimentation under study. Data collected to determine whether or not photosynthetic reoxygenation can be predicted from knowledge of light intensity and such stream analyses as temperatures, color, turbidity, nutrient level and chlorophyl. Data under analysis and evaluation. Lab reaeration apparatus consisting of cylinders mixed in manner analogous to streams modified to contain river muds. Using Passaic River water no significant differences between measured and literature oxygen saturation values. Evaluation of effect of river contaminants on reoxygenation rate in progress.

1. PESTICIDE RESIDUES AND AQUATIC ENVIRONMENTS

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0183, DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY

UNKNOWN, Delaware River Basin Comm., *Trenton, New Jersey*

Description: A three-year study (0.5 years construction and 2.5 years operation) to develop design and cost data for a regional facility capable of providing 85-95% BOD removal from a combined municipal- industrial waste is proposed. Construction and operation of a 100-gpm pilot plant consisting of flow equalization, neutralization, primary settling, activated sludge treatment, microstraining and chlorination is proposed. The combined waste will be 20% municipal and 80% industrial; consisting of pesticides, dyes, plastics, solvents, phenols and other refractory organic chemicals. Sewage and the wastes from seven-plus industries would be hauled by tank truck to the pilot plant daily.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0184, DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY

P.J. WEBBER, Delaware River Basin Comm., *Trenton, New Jersey*

Studies have indicated the potential economic, technical, and other advantages which can be realized from the construction of a single regional treatment facility at Deepwater, Salem County, New Jersey to solve the liquid wastewater treatment problems of 10 major industries, and the adjacent municipalities in Salem and Gloucester Counties along the Delaware River Estuary. Industrial wastes include pesticides, dyes, heavy metals, plastics, solvents phenols and other refractory chemicals.

A pilot plant is operative at the site of the regional facility to determine treatability characteristics, develop cost and design criteria for a full scale facility, test methods of secondary and advanced waste treatment and provide data to base on equitable cost apportionment system.

Wastes are being hauled by tank truck to the 50 gpm pilot plant. Currently, BOD removals are in excess of 90% and there are similar removals for heavy metals (as a result of a neutralization unit) and phenol.

SUPPORTED BY Delaware River Basin Comm. - Washington

1.0185, CONCENTRATION AND ANALYSIS OF PESTICIDES AND OTHER RECALCITRANT MOLECULES IN WATER SUPPLIES BY ULTRAFILTRATION

V.H. EDWARDS, Cornell University, School of Chemical Engineering, *Ithaca, New York* 14850

This research seeks to determine whether ultrafiltration or reverse osmosis can be used effectively to concentrate aqueous solutions and suspensions of pesticides and other biologically and chemically recalcitrant organic molecules for purposes of more accurate and sensitive sampling and analysis of water supplies. A second objective will be the development of a prototype design for a field sampling device based upon the principles developed in this research.

Principal elements in this research will include: 1. Screening of various commercial ultrafiltration membranes for suitability in concentration of selected test pesticides. 2. Study of the influence of pertinent variables (such as pH, temperature, pesticide concentration, and mineral and sediment content and composition) on ultrafiltration flux rates and rejection efficiency of membranes for selected pesticides. 3. Implementation of these results into the preliminary design of a prototype field sampling device. (Subsequent research based upon this work will be directed towards construction and field evaluation of this device and technique.)

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0186, AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER

P.J. ZWERMAN, State University of New York, School of Agriculture, *Ithaca, New York* 14850

The objective of the project is to develop working approximations of parameters necessary for estimating the contributions of nitrogen and phosphorus from agricultural land to water for two specific purposes: (a) to permit estimation of the contributions from land under selected major land use systems, and (b) to permit identification of farming practices by means of which such contributions may be minimized.

To these ends, the immediate objectives would be to determine the effects of time, rate, and placement of fertilizers along with selected cultural practices, on the forms and amounts of nitrogen and phosphorus contributed to water under conditions of soil and climate representative of very extensive areas of the humid temperate region. In addition pilot analytical studies will be conducted to determine whether or not the major problems of determining organo phosphate and carbamate pesticides in the water samples can be solved adequately to justify the additional cost of monitoring them in the same experiment.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0187, QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA

E.H. BRYAN, Duke University, School of Engineering, *Durham, North Carolina* 27706

The objective of the proposed research is to determine the relationships between land use and the quality of storm water drainage in an urban area of North Carolina. The drainage basin selected for study will typify the pattern of land use in an urban and urbanizing setting in North Carolina. Quality of storm water from commercial, residential, industrial, public and institutional sub-basins with respect to selected parameters such as alkalinity, pH, chlorides, solids, nitrates, phosphates, pesticides, herbicides, coliforms, biochemical oxygen demand, organic carbon and others will be related to existing and changing patterns of land use. The project will be aimed at furnishing a background of information as to sources and amounts of pollutional substances contributed in a diffuse pattern to natural drainage channels.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0188, CHROMATOGRAPHIC CONCENTRATION OF PESTICIDES FROM A LARGE MASS OF WATER

T. ITO, East Carolina University, School of Arts, *Greenville, North Carolina* 27834

The objective of this research is to try to develop a more adequate than presently available method to extract and concentrate pesticides from a large mass of natural water.

Reversed-phase partition column chromatography is the method of choice to determine what specific requirements are to be satisfied to accomplish such objective.

Suitability of various types of solid supports and stationary phases will be examined to find the best condition. 'Anchored' stationary phases, which are covalently bonded to solid supports, will be prepared to determine their suitability for extraction and concentration of pesticides from a large mass of water.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0189, CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS

T.J. SHEETS, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27607

The movement of DDT, toxaphene, trifluralin, and fluometuron in surface water arising from natural rainfall in cotton fields will be studied. Cotton will be grown and sprayed with the four pesticides at dosages and frequencies employed by farmers for pest control. Surface water from small plots within large (3 to 5 acre) experimental fields will be collected after each rain during the growing season and analyzed for the pesticides.

Seasonal changes of pesticide residues in a farm pond located within one of the experimental areas will be followed by analyzing water and sediment after each rain.

The persistence of the four pesticides and their movement downward will be studied in two soils (the two experimental sites). Possible contamination of ground water will be investigated by analyzing water from wells located within cotton fields that are sprayed with the four pesticides during each of three years.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0190, CENTER FOR STUDY OF THE HUMAN ENVIRONMENT

R.R. SUSKIND, Univ. of Cincinnati, School of Medicine, *Cincinnati, Ohio* 45221

The Center for the Study of the Human Environment is a research and educational resource devoted to the study of environmetal problems which affect man's health and to research training in pertinent scientific disciplines. The present subject areas on which coordinated research efforts are focused include (1) trace metal metabolism (2) toxicologic problems of heavy metals (3) carcinogenesis and teratogenesis (4) pulmonary problems of environmental origin (5) pesticides (6) organic solvents (7) plastics and (8) analytical and environmental methodology. The environmental origins of these problems are related to air and water quality, solid waste management, industrial and agricultural activity, and consumer products including food, drugs, household and other manufactured materials. The training program is intimately related to the research efforts and includes masters and doctoral programs in disciplines encompassed within the arena of environmental health.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

1.0191, CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE

G.O. SCHWAB, Ohio State University, School of Agriculture, *Columbus, Ohio* 43210

Both field and laboratory studies will be involved in measuring the quantity and kinds of soluble and suspended constituents in drainage water from agricultural lands. Precipitation, runoff, soil and air temperature, solar radiation, and other hydrologic factors will be recorded. About eleven common soil chemicals, including nitrogen and phosphorus, and pH, electrical conductivity, atrazine herbicide, and aldrin insecticide in the runoff and in the sediment will be evaluated. In the field studies near Sandusky, Ohio, water samples will be obtained from tile and surface drains installed in one-half acre plots. The land will be cropped in corn with no tillage and conventional tillage practices as variables.

In the laboratory leaching of phosphorus from columns of soil from the field plots will be conducted using various applications of phosphorous. Runoff from small bins containing a fine- and a coarse- textured soil will be analyzed for phosphorous and other ions. The objective of the leaching studies is to identify discrete compounds formed and to determine threshold concentrations where soil contributes phosphorous to lake water.

Water samples taken during the 1969 growing season were high in sediment, and nitrates, but low in phosphorous and dicamba. Atrazine and dicamba losses averaged about 13 percent and 32 percent, respectively, of the amount applied. Water from tile was generally much lower in pollutants than surface water.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0192, CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE

G.O. SCHWAB, Ohio State University, Agricultural Experiment Sta., *Columbus, Ohio* 43210 (OHOSS-187)

OBJECTIVE: Determine the quantity and kinds of soluble and suspended constituents in water which drain from agricultural lands into Lake Erie. Evaluate the effect of different drainage methods, tillage operations, and rainfall characteristics on constituents entering Lake Erie from agricultural lands. Determine the rates of leaching of phosphorus from fine and coarse textured soils, identify discrete compounds formed, and determine threshold concentrations where soil contributes phosphorus to lake water.

APPROACH: Field measurements of sediment, plant nutrients, and several pesticides will be taken from tile and surface drainage systems at North Central Branch, OARDC, near Castalia. Plots are in corn with no tillage and conventional tillage practices. Laboratory studies of phosphorous movement in this soil will also be made with radioactive tracers.

SUPPORTED BY Ohio State Government

1.0193, PESTICIDES MOVEMENT FROM CROPLAND INTO LAKE ERIE

A.C. WALDRON, Ohio State University, School of Agriculture, *Columbus, Ohio* 43210

In order to effectively regulate the occurrence of pesticide residues in lakes and streams it is necessary to determine the source and cause of contamination. Data is yet insufficient to determine the greater sources of pesticide pollution in Lake Erie although agriculture receives the brunt of public disfavor as the major contributor. This study is designed to assess the percentage of pesticide pollution in rivers of northern Ohio and subsequently in Lake Erie that does originate from agricultural lands and agricultural use.

Samples of water, sediment and mussels as available taken from six sites on each of the Maumee, Portage, Sandusky, Huron, and Grand Rivers will be collected and analyzed monthly. Collection sites will represent the agricultural areas as well as metropolitan discharge in the rivers. Additional samples will be taken from the mouths of the rivers and from adjacent areas in Lake Erie. Pesticide residue analyses will coincide with pesticide use relating to cropping practices and soil types. The data accumulated over the 3 year period proposed will be used to help assess agriculture's contribution to the pollution problem and provide criteria for making corrections in agricultural practice where necessary.

Analytical work shall be conducted at the pesticide Analytical Laboratory at The Ohio State University.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0194, RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION

L.L. HARROLD, U.S. Dept. of Agriculture, Soil & Water Cons. Res. Div., *Coshocton, Ohio* 43812 (SWC-027-CCOS-2)

OBJECTIVE: Determine the transport rate of sediment, nitrogen, phosphorus, and selected chlorinated insecticides from agricultural lands into surface and subsurface waters and the transport mechanism thereof.

APPROACH: Develop techniques and equipment for sampling soils, crops, surface runoff, and groundwater recharge and discharge on agricultural watersheds having surface application of selected insecticides and plant nutrients. Relate concentration of pollutants in samples to flow rates. Quantify for various periods total pollutant delivery to surface and subsurface water and relate same to rainfall, soil moisture, soil, geology, and land treatment.

PROGRESS: Great care must be exercised in collecting, preparing, and storing runoff samples to be used in studying the loss of pesticides and other chemicals from agricultural lands. Several individual samples must be collected at variable predetermined time intervals throughout the runoff hydrograph of each storm. Each sample must be related to runoff rate at the time of sampling. A detailed description of the construction and operation of automatic sampling equipment installed on experimental watersheds at Coshocton, Ohio, has been prepared. The equipment remains on a standby basis until the onset of runoff. A predetermined sampling sequence collects samples in 1-gallon glass jugs, which are stored in a refrigerator. Sampling is automatically terminated. Greenhouse and field experiments were conducted in which corn was grown on Muskingum silt loam to which dieldrin had been added. The plants grown in the greenhouse were protected from aerial contamination, whereas no attempt was made to control this in the field. The corn was harvested at maturity and the dieldrin contents of the leaves, stalks, kernels, and cobs were determined. Only slight differences were found between the two experiments in the dieldrin contents of the stalks, kernels, and cobs. But the leaf to stalk ration of dieldrin concentrations in the field-grown plants was 50 times higher than that found in the protected plants. This large difference is attributed to aerial contamination of the foliage.

1. PESTICIDE RESIDUES AND AQUATIC ENVIRONMENTS

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - S.W.C

1.0195, MICROWAVE-EXCITED EMISSION DETECTOR FOR PESTICIDES AND TRACE METAL ANALYSIS

G.W. WOOTEN, Monsanto Research Corporation, *Dayton, Ohio* 45407 (68-01-0085)

Description: Develop, fabricate, demonstrate and deliver two (2) operational prototype Microwave-excited emission detector instruments suitable for analysis of pesticides and trace metals in water. These apparatus shall be so constructed as to insure successful interfacing with existing equipment in the Analytical Quality Control Laboratory.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0196, DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS

G.B. TRIPLETT, Ohio Agric. Res. & Dev. Center, *Wooster, Ohio* 44691 (OHO00306)

OBJECTIVE: Develop herbicide systems for non-tilled crop production that control unwanted vegetation and minimize hazards: current crop, succeeding crops, of soil and water contamination.

APPROACH: Herbicides will be screened to determine their value in controlling unwanted vegetation and their hazard of crop injury. Promising materials and combinations of materials noted in screening trials will be evaluated for their adaptability to non-tilled crop production following sod and clean tilled crops. The best systems emerging from this research will be evaluated for contamination of crops, injury to following crops, contamination of surface water runoff.

PROGRESS: Atrazine at 3 to 4 pounds per acre is used to destroy perennial meadow grasses prior to planting corn. In a greenhouse study, pots containing oat plants were sprayed with several rates of atrazine alone and with oils and/or surfactants. Analysis of leaf tissue and soil showed that from 40 to 60 percent of the atrazine applied with oil was retained in the plant tops, a three- to five-fold increase over water alone or water plus surfactants. Even after the plant tops were dead, up to 20% of the atrazine recovered was in plant tops...Preliminary studies indicate atrazine present in plant tissue may not be as biologically active as the same amount in the soil. This would help explain the observed lower amount of carryover of atrazine applied to growing vegetation.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0197, DEVELOP EFFECTIVE TREATMENT METHODS FOR HARD PESTICIDES

UNKNOWN, U.S. Environ. Protection Agcy., Ada Laboratory, *Ada, Oklahoma* 74820

No summary has been provided to the Science Information Exchange.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0198, QUANTITATIVE METHODS FOR PESTICIDES IN NATURAL WATERS

I.H. SUFFET, Drexel University, Graduate School, *Philadelphia, Pennsylvania* 19140

The long-term objective of this study is to develop reproducible quantitative analytical techniques for organophosphate and carbamate pesticides in natural waters. These objectives can be fulfilled by the development of the most efficient liquid-liquid extraction and cleanup procedures.

The best analytical conditions for liquid-liquid extraction and cleanup should be based upon thermodynamic data. Presently, the choice of extraction parameters is based upon the criteria of intuition which is then followed by empirical trial and error analysis. This study will attempt to develop thermodynamic data based upon the partition coefficient expressed as a p-value so that a rational choice of extraction parameters can be made for different natural waters.

The primary goal of the study will be directed toward the analysis of the capability of the p-value for rational choice of extraction parameters in different types of natural waters; a clean low turbidity type, a polluted high turbidity type, and a high dissolved solids type. The extraction parameters obtained then will be evaluated in terms of the concentrations found in natural waters. As necessary, cleanup of natural water extracts will also be guided by p-values between immiscible solvents.

The determination of the p-values for organic pesticides will enable a theoretical approach a) to devising quantitative multiple screening procedures for organophosphates and carbamates, b) delineating the conditions to avoid cleanup problems for quantitative analysis of these pesticides in natural waters and c) devising quantitative cleanup procedures for these pesticides.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0199, PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS

A. PETERS, Franklin Institute, *Philadelphia, Pennsylvania* (14-12-904)

Description: The Franklin Institute during this twelve (12) month literature survey will screen, abstract and index pertinent articles and documents related to the overall urban runoff pollution problem. Phase I will update the Selected Urban Storm Water Runoff Abstracts from July 1968 through December 1969. Phase II would provide a continuous survey during 1970. Phase II would provide a limited number of special urban runoff literature surveys. The compilation of July 68-Dec. 69 abstracts and the 1970 abstracts would be reproduced and distributed through the Research and Development Project Reports System. Urban runoff pollution includes storm water discharges, combined sewer overflows, unsewered urban runoff, and the associated effects on the receiving waters, including sediment, nutrients, pesticides, salt, etc.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0200, THE BIOASSAY OF WATER POLLUTANTS WITH CULTURED MAMMALIAN CELLS

H.W. FISHER, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

In the present study we are determining the titration endpoints of toxicity of water pollutants by quantitative determinations with mammalian cells cultured in vitro. The research plan proposes to extend this study in two ways: In the first series of experiments, the plating efficiency and growth rate assays would also be carried out with a cell culture of a cold-blooded vertebrate, such as the cell line derived in 1960 by Wolf and Quimby (Science 135, 1965 (1962) from gonadal tissue of rainbow trout, Salmo gairdneri. In the second study, chromosomal analyses of cells growing in toxic concentrations of the pollutants would be carried out. Cells would be grown in concentrations of the pollutants at the threshold of toxicity as determined in our present experiments and chromosomal aberrations or changes in ploidy produced by the inorganic pollutants, herbicides, pesticides, or detergents would be documented.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0201, TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE

C.E. OLNEY, Univ. of Rhode Island, School of Agriculture, *Kingston, Rhode Island* 02881

There is virtually no information on the extent of environmental contamination by pesticides in the state of Rhode Island and this project is aimed at filling this gap in our knowledge.

Samples of water, sediment, and aquatic life from selected streams and ponds in the state will be collected at regular intervals and analyzed for chlorinated hydrocarbon and organic phosphate pesticides. Watersheds, both rural and urban, where pesticides have been used as well as those where chances of direct contamination are remote will be sampled.

Should biologically significant residues be found, an attempt will be made to trace the source of the pesticide.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0202, TRANSFER OF PESTICIDES THROUGH SOILS, WATER, SEDIMENTS AND AQUATIC LIFE

C.E. OLNEY, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881 (RI00006)

OBJECTIVE: Assess the extent of contamination of soils and water bodies of Rhode Island by pesticides: Extent of environmental contamination by pesticides in the estuaries and salt water bodies of the state: Determine source of any pesticide pollutants.

APPROACH: Samples of soil, water, sediment and aquatic life from selected areas, streams and ponds in the state will be collected at regular intervals and analyzed for chlorinated hydrocarbon and organo- phosphate pesticides. Watersheds, both rural and urban, where pesticides have been used as well as those where chances of direct contamination are remote will be sampled. Samples of sediment and aquatic life from stations in Narragansett Bay and coastal regions of the state will also be analyzed. Should biologically significant residues be found, attempts will be made to trace the source of the pesticide.

SUPPORTED BY Rhode Island State Government

1.0203, FISHERIES UNIT

R.L. APPLEGATE, South Dakota State University, Agricultural Experiment Sta., *Brookings, South Dakota* 57006 (SD00914)

OBJECTIVE: Research various problems of fish and aquatic habitats in South Dakota.

APPROACH: Work program varies according to the annual agreement of the coordinating committee.

PROGRESS: This project is part of the University's contribution to the Cooperative Fishery Unit as per memorandum of agreement. Projects included: fish population of Lake Poinsett as indicated by the catch of four types of gear; food selectivity of bigmouth buffalo in Lake Poinsett; survey of chemical biocide levels in Lake Poinsett; population dynamics of Daphnia pulex in Lake Poinsett.

SUPPORTED BY South Dakota State Government - Pierre

1.0204, QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF

J.N. DORNBUSH, South Dakota State University, School of Engineering, *Brookings, South Dakota* 57006

Description: The objectives of this project are to: (1) quantify the pollutional constituents in agricultural surface runoff and express them as contributions per unit area or per unit runoff (2) relate unit pollutant contributions to (3) relate the portion of pollution constituents associated with both dissolved and suspended solids.

Composited and grab samples of surface runoff will be collected from eight carefully selected representative drainage basins using automatic self-starting samples. Rainfall on and flow from the drainage areas will be measured. Spring runoff from frozen land surfaces would receive special attention. Drainage areas consist of crop land with both row and small grain crop cover, pasture and grassland with one area including a feedlot installation. Analyses of samples will include determination of nitrogen and phosphorus forms, pesticides, BOD, COD, dissolved and suspended solids, coliform and other fecal organisms.

Periodic recording of the land use changes and prevailing drainage basin cover conditions would be accomplished utilizing aerial reconnaisance. Aerial photography will be used to provide permanent land use records. Records of applications of fertilizers and pesticides obtained from the land users will be correlated with pollutant contributions in the runoff. It is anticipated that the quantitative information provided by this investigation may be extrapolated to apply throughout the upper great plains region.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0205, CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES

J.G. NICKUM, South Dakota State University, School of Agriculture, *Brookings, South Dakota* 57006

The research plan proposes to make it possible to describe the chemical, physical, and biological dynamics of heretofore unstudied lakes. This will provide information concerning the relationship between land use and water quality of lakes.

The project will study the present, the seasonal variation, and the possible year to year variation of water quality. This will be accomplished by biweekly sampling during June, July, and August, and monthly throughout the remainder of the year. In addition, samples of water flowing into the lakes will be taken whenever rainfall is sufficient to cause a runoff into each lake.

The chemical content of the water will receive special attention in that the levels of various chemical biocides in the ecosystem will be determined. Pesticide residues will include endrin, dieldrin, aldrin, heptachlor, heptachlor epoxide, DDT, DDD, DDE, lindane, toxaphene, and the chlorophenoxy compounds. Pesticide residues will be extracted from five types of materials including water, mud, plant material, small aquatic animals and fish.

The field data will be used to provide information concerning the relationship between land use and the dynamics of a lake.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0206, DESIGNING A GLOBAL ENVIRONMENTAL MONITORING SYSTEM

UNKNOWN, Internat. Coun. of Sci. Unions, *Zurich, Switzerland*

One of the chief functions of the International Council of Scientific Unions (ICSU) is to advise UN special agencies. To that end ICSU's Special Committee on Problems of the Environment will prepare a design for a global environmental monitoring network for submission to the 1972 conference. Five scientists -- a botanist from England, a zoologist from Sweden, a chemist from Germany, a biologist from the Soviet Union, and an ecologist from the United States -- will devise a worldwide network of stations to measure certain materials in the environment that affect man's well-being, such as carbon dioxide in air or pesticides in birds, fish, or animals. Their recommendations will be presented for approval to the SCOPE meeting in Canberra in September, 1971, and then will be submitted for ratification to the Stockholm conference.

SUPPORTED BY Ford Foundation - New York, N.Y.

1.0207, EFFECTS OF WATER POLLUTION ON ZOOPLANKTON

D.L. BUNTING, Univ. of Tennessee, Graduate School, *Knoxville, Tennessee* 37916

No summary has been provided to the Science Information Exchange.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

1.0208, PESTICIDE LEVELS IN WATER AND WILDLIFE OF REELFOOT LAKE, TENNESSEE

J.W. HENSON, Univ. of Tennessee, School of Liberal Arts, *Martin, Tennessee* 38237

The proposed research involves field sampling followed by laboratory analysis in the determination of types and levels of pesticide pollution in water and wildlife of Reelfoot Lake, its tributaries and adjacent lowlands. Water and fish samples would be collected monthly throughout the year, with additional sampling during the summer and after rains. Samples also would be taken from shallow wells near the lake that are used as human water supplies. Additional tests of wildlife would accompany instances of chronic or acute wildlife mortality. Other investigations would attempt to identify the primary sources of any identified pesticide pollutants.

Samples would be analyzed for residues of those pesticides commonly used in the lake watershed. These include both organochlorine and organophosphorous insecticides. Analytical procedures would be adapted from those in the literature. Pesticide residue identification and quantification would be made with a gas liquid chromatograph, equipped with 3H E. C. and alkali flame ionization detectors. Column, paper, and thin-layer chromatographic methods would be utilized in sample cleanup and as independent methods of detection.

The data would be correlated with hydrological and meteorological information recorded at the weather station of the Reelfoot Lake National Wildlife Refuge.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0209, INVESTIGATION OF RICE IRRIGATION RETURN FLOWS - TEXAS COASTAL PRAIRIE REGION

C. TUCK, State Water Development Board, *Austin, Texas* 78711

The quantity and quality of irrigation return flow water from rice culture is being investigated for future planning of the return flows available for reuse in the Texas Coastal Prairie Region. There are two sample study areas in the project. One area uses a ground water supply and is instrumented for continuous operation. The other area uses a surface water supply and is being studied on a reconnaissance level.

The quantity of return flows will be obtained on a percent basis and/or on an acre-feet/acre basis from the records of water diversions, rainfall and volume of drainage that are collected. The quality of these return flows are analyzed from samples taken to investigate the possible change in water quality due to fertilizers and pesticides used in the culture of rice farming.

SUPPORTED BY Texas State Government - Austin

1.0210, CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES

P.R. ATKINS, Univ. of Texas, School of Engineering, *Austin, Texas* 78712

Project Objectives and Description of Work: Pesticide usage in many portions of the world is increasing at an accelerated rate. The production of the chemicals required to satisfy these demands often results in wastes which may be harmful to aquatic organisms, plants, animals, and man. Information concerning these waste streams, is scattered, confused, and often unavailable. The purpose of this proposed study is to investigate the quantity and quality of pesticide manufacturing waste streams and to evaluate the methods presently being employed to treat and dispose of the pollutants. The study area involved will be limited to the continental United States and Canada.

The project will include: 1. A comprehensive review of the literature dealing with historical, present and projected pesticide usage, manufacture, and waste water treatment. 2. A survey of a number of major manufacturing plants, including site visits and personal interviews where possible. The production process used, the wastes produced, and the treatment and disposal methods utilized will be investigated. 3. A completion and evaluation of the information obtained from the literature, site visits, industry reports, agency reports, research projects, and other sources. 4. The development of recommendations on the type of research needed in this area. 5. The development of a complete and comprehensive bibliography on pesticide wastes and waste treatment.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

1.0211, ELECTROPHORETIC CLARIFICATION OF WATER

E.A. HILER, Texas A & M University System, School of Agriculture, *College Station, Texas* 77843

This research involves a study of the utilization of the electrophoretic method for pollutant removal from natural waters. Electrophoretic clarification is effected by removal of charged colloidal particles from water as the suspension is passed through a dc electric field.

The purpose of this research is to investigate the removal of colloidal clay, bacterial and pesticidal pollutants from water by the electrophoretic method. The objectives are as follows: (1) development of an optimal electrode arrangement based on results of theoretical and basic experimental research; (2) characterization of various contaminants present in typical natural waters; and (3) evaluation of the efficiency of removal of these pollutants by the electrophoretic method.

This study will provide a critical evaluation of the feasibility of the electrophoretic method of water clarification.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0212, LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES

J.S. PALMER, U.S. Dept. of Agriculture, Toxicological Research Lab., *Kerrville, Texas* 78028 (ADPA7-19R)

OBJECTIVE: Develop the biochemical processes occurring in livestock which alter and eliminate various pesticides, and utilize the derived information in solving the problem of chemical residues in products intended for human consumption.

APPROACH: The great variations that exist in the toxicity of organic chemical compound to which livestock, chiefly cattle and sheep, may be exposed will be investigated. Physical condition and stresses having a major role in the response of animals to these compounds. An understanding of detoxication mechanisms, and the situations in which they are utilized, will facilitate the use of chemicals that are more readily eliminated, thereby reducing the hazard to animals. To delineate the different detoxifying processes, the enzymes, metabolites, and conjugation products will be determined.

PROGRESS: The metabolism and residues of radioisotope-tagged ferbam were determined for a period of 76 hours after a sheep was treated. Quench curves for each tissue, blood, urine and feces were established at various intervals of time and autoradiograms made. Another sheep was similarly exposed to confirm these results. The effect of DDT and its metabolites on adult chickens is being studied. It includes toxicity, egg production, fertility, egg shell consistency, and residues in various body tissues. The evaluation of an insecticidal formulation of crotoxyphos as a sheep dip was made. Indications are that degradation occurs on storage, resulting in an unstable and ineffective treatment. Residual and toxicological aspects of 2,4,5-T in sheep and cattle, exposed over a 9-month period, completed. Negative results on analyses of watershed samples as to evidence of possible pollution by pesticides.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - V.S.R

1.0213, PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN

D.B. JOHNSTONE, Univ. of Vermont, Agricultural Experiment Sta., *Burlington, Vermont* 05401 (VT00155)

Objective: Obtain an ecological evaluation of the various types of microorganisms present in the waters of Lake Champlain. Determine the influence on microorganisms of pesticides in an aquatic environment. Determine the influence of pesticides on the number and distribution of microorganisms in an aquatic environment.

Approach: The aquatic microbial ecology in areas adjacent to the shoreline and relatively free of agricultural chemicals will be examined by standard microbiological precedures for culturing and enumerating microorganisms. This will be correlated with basic limnological data such as dissolved oxygen, temperature, etc. obtained by other investigators. Special emphasis will be placed upon those groups of bacteria that are active in organic matter decomposition such as nitrogen transformations.

Progress: Macro-environmental studies were conducted in the southern portion of Lake Champlain from Whitehall to Burlington. Bacterial populations were correlated with various limnological parameters. This data may become useful in evaluating the pollution by the paper mills as well as thermal pollution by a proposed nuclear power generating station in this area. A new device was designed and built to collect water samples aseptically at various depths. The taxonomy of certain bacteria is being studied by polyacrylamide gel electrophoresis of proteins. An investigation of the nutritional characteristics of representative yeast isolates from Lake Champlain was completed.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0214, DDT IN SNOW FALLEN AT HIGH ALTITUDE SINCE 1950

T.J. STENGLE, Univ. of Vermont, School of Arts, *Burlington, Vermont* 05401

Description: This study is an add-on to an ongoing project already funded by private funds, foundations and federal grant. FWQA support of this project is to collect samples of snow from depths down to 100-150 feet on Mt. Logan in the Yukon Territory. Samples will be analyzed for DDT and similar organochlorides by the FWQA Analytical Quality Control Laboratory in Cincinnati, Ohio.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0215, DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS

M.L. YATES, U.S. Dept. of the Interior, Geological Survey, *Arlington, Virginia* 22209

The effect of extensive use of organophosphorus pesticides on the water quality in many areas of southern Florida needs to be evaluated. Over 268,000 lbs of organophosphates were employed from July 1966 to July 1967 in Dade County alone, National Pesticide Monitoring Program includes a need to evaluate residue levels of many organophosphates in water systems, but little data has so far been produced. If a serious residue problem exists then programs to reduce or eliminate the use of certain materials may be required.

Compounds to be studied, based on amount of use in given areas, include malathion, parathion, guthion, dimethoate, delnav, ethion, tedion, and trithion. Data on the amount and types of organophosphorus residues in water, sediments and probably plant life will be obtained. Degradation and resistance studies on specific compounds will be run. Parameters such as pH, Eh, D.O. and temperature of the water environment will be included. The results will aid in evaluation of the source, transport and ultimate fate of these compounds in the hydrologic cycle. The pesticide analyses will be carried out in the laboratory using techniques of extraction, cleanup and instrumental analysis developed in conjunction with other Survey labs.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

1.0216, IMPROVING WATER QUALITY BY REMOVAL OF PESTICIDE POLLUTANTS WITH AQUATIC PLANTS

S.W. BINGHAM, Virginia Polytechnic Institute, School of Agriculture, *Blacksburg, Virginia* 24061

The proposed research involves investigations directed at the determination of the fate of pesticides in water and aquatic environment. The main approach is to determine the effectiveness of various aquatic plants for removal of pesticide residues from water.

In the growth chamber and greenhouse, radioisotopic methods will be used to evaluate the effectiveness of selected aquatic plants for degradation of residual pesticides. The plant tissues and water in the cultures will be sampled and radioassayed at intervals after exposure to radioisotopically labeled pesticides. Quantitative changes of the pesticide levels in the water and tissues will be determined by low background gas flow counting and/or liquid scintillation spectrometry of ground plant material, fractional extraction, or nutrient media. Degradation of labeled pesticides in aquatic plants will be evaluated by the collection of carbon dioxide. For partial degradation of the pesticide molecule, chemical extraction, fractionation, and chromatography of authentic compounds and unknowns will be involved.

For these studies, a few relatively new but already economically important pesticides will be selected. In a similar manner, specific aquatic plants that are important weed species will be evaluated for channels of pesticide degradation.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0217, PESTICIDE MONITORING

W.D. BRUNSON, State Dept. of Game, *Olympia, Washington* 98501

Project: Pesticide monitoring.

Objective: To determine the levels of pesticide residues in fish hatchery water supplies, natural waters, and fish food.

Procedures: Samples will be collected statewide and transported to the Western Fish Disease Laboratory, Bureau of Sport Fisheries and Wildlife, Seattle, for preparation, extraction, and gas chromatographic analysis of chlorinated hydrocarbon pesticide residues.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0218, SOURCES OF QUALITY IMPAIRMENT OF SURFACE WATERS

B.L. CARLILE, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP00034)

OBJECTIVE: Establish procedures for assessing the contributions of all components of the community; including agriculture, to the degradation of quality of water in surface streams.

APPROACH: Select sampling stations on streams within the watershed to provide information on pollutional levels as related to all probable sources. Follow changes in quality over the seasons. Quality measurements will include ionic constituents, sediment, pesticides and coliform counts.

SUPPORTED BY Washington State Government - Olympia

1.0219, OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS

E. HINDEN, Washington State University, School of Engineering, *Pullman, Washington* 99163

The method of transport to and the occurrence of pesticides in the aquatic environment is of extreme interest today. The increased use of pesticides for achieving higher agricultural and silvicultural productivity has allowed a greater amount of pesticides to enter into the aquatic environment. Though these amounts are generally in sublethal dosages, their presence constitutes a potential hazard. Certain pesticides can be concentrated in tissues of most organisms, thus entering in the food cycle of organisms in the aguatic habitat.

The purpose of this study is two fold. One purpose is to study the distribution of a chlorinated organic and organic phosphorus insecticide on an agricultural plot receiving insecticide application. A distribution budget will be made from analysis of soil, plant, and insecticide removal by irrigation runoff water and loss to the atmosphere taken throughout the growing season. Particular attention will be paid to that amount being carried off by the irrigation runoff water. During the second year insecticides will not be applied. A distribution budget will be made of the insecticides present on the plot. Emphasis will be placed on the insecticides leaching off the field in the irrigation runoff water.

The second purpose of the study is to determine the seasonal variation in the pesticide content of a dimictic and of a polymictic reservoir. Comparison will be made of the pesticide content of the water at specific depths, i.e. Epilimnion, Metalimnion and Hypolimnion. The surface inflows and outflows to the reservoirs will be sampled to better assess the pesticide variation. Samples of aquatic organisms, i.e., plankton, benthos, fish and snails, will be taken to determine the concentration of pesticides in organisms inhabiting the reservoir. Comparisons will be made of the pesticide content of those organisms feeding at specific depths.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0220, MICROBIOLOGY OF FARM PONDS

H.A. WILSON, West Va. University, Agricultural Experiment Sta., *Morgantown, West Virginia* 26506 (WVA00132)

OBJECTIVE: Study qualitatively and quantitatively, the microbiological population of fresh water systems and the factors influencing this population; whether certain special bacterial groups such as cellulose decomposers, nitrifiers, nitrogen fixers, etc., are present; the effect that pesticide and herbicide residues have upon the microbial population of such waters and whether any members of the water microflora are capable of degrading either the active or inert constituents of such materials; the potential danger to livestock drinking from ponds and stagnant pools when heavy algal growths appear; the probable pollution hazards to ponds and streams from garbage dumps, sanitary landfills and domestic sewage from private residences.

APPROACH: Standard microbiological procedures will be the general basis of study.

PROGRESS: Coliform and enterococci densities were greater in ponds receiving run-off water from livestock areas. No psychrophilic bacteria, optimum growth below 20 C, were found although some isolates grew slowly at temperatures near O C. The relative stability of the farm pond waters studied was about 99% as determined by the methylene blue test. This was substantiated by the biochemical oxygen demand (BOD), which ranged from 1.1 to 315 mg oxygen consumed per liter. Rivers with BOD values between 1 and 4 ppm have been considered clean. Sediment BOD values ranged from 20 to 45 ppm per gram on an oven dry basis. This indicates the considerable amount of organic matter in pond sediment. The bacterial flora of ponds apparently is predominantly small gram negative rods with gram positive rods and cocci in considerable lesser numbers. This corresponds to findings of fresh water lakes. Microscopic examination of slides submerged in pond water revealed considerable numbers of algae as well as bacteria. Most of the algae were diatoms belonging to the genera Fragilaria, Diatoma, Synedra, Surirella, Stauroneis, and Navicula.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0221, EVALUATION OF PESTICIDE SOURCES AND LEVELS TRIBUTARY TO LAKES MICHIGAN AND SUPERIOR

L.A. LUESCHOW, State Div. of Env. Protection, *Madison, Wisconsin* 53701

Description: To identify sources and quantities of chlorinated hydrocarbon pesticide residues in the Lake Michigan and Superior drainage basin and to establish a bank of data so that pesticide control programs can be evaluated.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0222, TERMINAL RESIDUES OF CHLORINATED HYDROCARBON PESTICIDES IN LAKE MICHIGAN AND ASSOCIATED TRIBUTARIES

G.M. BOUSH, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01667)

OBJECTIVE: Study the metabolic fate of persistent chlorinated hydrocarbon insecticides, particularly DDT and dieldrin in the microorganisms that are isolated from the waters of Lake Michigan and associated tributaries. Study is designed to find the biological effects of such microbial conversion of pesticides in the aquatic environments.

APPROACH: First isolate microorganisms from various locations and incubate the insecticide labeled with radioactive carbons to find the metabolic capability of such microorganisms. When the general tendency of the metabolic capabilities by the microorganisms is established, efforts will be then made to study the presence of such metabolites in the natural aquatic environment.

SUPPORTED BY Wisconsin State Government - Madison

1.0223, INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES

G. CHESTERS, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

Detailed Objectives: a. To determine the extent of adsorption of certain insecticides by intact and fractionated lake sediments and the bonding mechanisms involved. b. To relate adsorption to a characterization and classification of lake sediments. c. To ascertain the effect of adsorption on chemical and biochemical degradability.

The extent of insecticide adsorption will be evaluated by equilibration and chromatographic techniques utilizing gas chromatographic and radioisotopic methods for insecticide determination. Properties of the insecticides and the sediments controlling the extent of adsorption will be ascertained. The effect of adsorption on the chemical and biochemical degradability will be determined by comparison of degradation rates in the presence and absence of adsorbents. Properties of sediments will also be related to their origin, environment of deposition and location to obtain a classification useful for prediction of the extent of insecticide accumulation in lakes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0224, INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES

G. CHESTERS, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01539)

OBJECTIVE: Determine extent of adsorption of insecticides by intact and fractionated lake sediments; relate adsorption to lake sediment characterization; and ascertain the effect of adsorption on insecticide degradability.

APPROACH: The extent of insecticide adsorption will be evaluated by equilibration and chromatographic techniques utilizing gas chromatographic and radioisotopic methods for insecticide determination. Properties of the insecticides and the sediments controlling the extent of adsorption will be ascertained. The effect of adsorption on the chemical and biochemical degradability will be determined by comparison of degradation rates in the presence and absence of adsorbents. Properties of sediments will also be related to their origin, environment of deposition and location to obtain a classification useful for prediction of the extent of insecticide accumulation in lakes.

SUPPORTED BY Wisconsin State Government - Madison

1.0225, ARTIFICIAL SUBSTRATE SAMPLERS AS INDICATORS OF WATER QUALITY

W.L. HILSENHOFF, Univ. of Wisconsin, School of Natural Sciences, *Madison, Wisconsin* 53706

Description: Because of their efficiency in detecting pollution, a variety of artificial substrate samplers are being used by an ever increasing number of agencies. This project intends to compare the efficiency of various types of samplers, to statistically evaluate the effectiveness and limitations of a new sampler under a variety of conditions, to demonstrate its effectiveness in detecting various types of pollution in streams, and to evaluate the role of various species of insects as indicators of water quality.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0226, CHLORINATED ORGANIC CONTAMINANTS IN THE MILWAUKEE RIVER

G.B. LEE, Univ. of Wisconsin, School of Engineering, *Madison, Wisconsin*

The occurences of chlorinated organic contaminants in the Milwaukee River system and western Lake Michigan have been investigated. Mass spectrometric analyses have verified the presence of mixtures of chlorinated biphenyls, and semi-quantitative GLC analyses based on commercial mixtures as standards have described the relative concentrations of the chlorinated biphenyls in fish and water throughout the study area. However, the lack of suitable standards results in the inability to adequately correlate environmental data because of the many isomers which comprise the mixtures.

The proposed study is an investigation of the aqueous environmental chemistry of the chlorinated biphyenyls. The initial objective is the development of analytical conditions and standards which enable quantitative analyses of individual or groups of isomers to be made. Subsequently, the fate of the chemicals in the environment will be determined through evaluations of the relative significances of sorption on sediments and planktonic communities, and stabilities of the chlorinated biphenyls toward biological and chemical degradation.

SUPPORTED BY Connecticut State Government - Hartford

1.0227, ATOMIC ABSORPTION ANALYSIS OF PHOSPHATES IN WATER

C.O. HUBER, Univ. of Wisconsin, Graduate School, *Milwaukee, Wisconsin*

Description: The objectives of this project would extend the advantages of this technique to analysis of pyrophosphate, organo- phosphates, sulfate, borate, arsenate, etc. The titration apparatus can be modified to further speed routine analysis. The extremely high sensitivities available via atomic fluorescence analysis will be applied to such inhibition titrations. Titrations of cations with anions must also be exploited. The data to be accumulated will allow previously unavailable observations as to relative stability of species at the flame temperatures and contribute a better understanding and application of the chemical effect in flame spectroscopy.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1C. FISH AND SHELLFISH

(Residues in Tissues) (Residues or Effects in Aquatic Food Chains From Nannoplankton to Birds and Man)

1.0228, EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT

H.H. FUNDERBURK, Auburn University, School of Agriculture, *Auburn, Alabama* 36830

The following studies will be undertaken: Absorption, translocation, and distribution of a xylem mobile herbicide (fluometuron) in Eurasian milfoil; effect of diquat, paraquat, fluometuron, dichlobenil, and at least 1 additional promising aquatic herbicide on certain metabolic processes of aquatic plants; degradation of diquat and 2,4-DBEE in an aquatic environment (water, plants, soil and fish); effect of promising aquatic herbicide on fish.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

1.0229, EFFECT OF ENDRIN ON EGG-SPERM FORMATION AND EMBRYONIC DEVELOPMENT

R.L. ARGYLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Marion, Alabama* 36756

Objectives: It has been well documented that certain chlorinated hydrocarbons have some effect on the reproductive potential of some bird populations. These effects have been manifest in reduced egg shell strength, high hatch mortality, and reduced clutch size to name only a few. It is speculated that chlorinated hydrocarbons may have a similar effect on fish reproduction and survival, especially in agricultural areas where pesticides are used intensively. Thus, it appears desirable to determine whether or not pesticides have an effect on eggs and sperm, and the development of the fertilized egg.

Procedure: For approximately a year prior to spawning, sexually mature channel catfish and goldfish will be fed pelletted feeds that contain 0, 1, 3 and 5 ppm endrin. Fish, water, soil and vegetation samples will be collected and analyzed periodically for endrin content. At time of spawning, fish will be paired with fish of opposite sex that have been similarly treated and other fish that have not been fed endrin. Effect will be based on hatching success and survival of fry.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0230, EFFECT OF ENDRIN ON FISH AND THEIR ENVIRONMENT UNDER CONTROLLED CONDITIONS

R.L. ARGYLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Marion, Alabama* 36756

Objectives: In most studies conducted in open ponds, streams and other natural or simulated natural facilities, variations in light, water exchange, soil types and other factors between remote and even adjacently located test areas make it difficult for the investigator to measure the true effect of the test material. Many times, differences in the type and amount of flora and fauna in the control facilities exceed these differences that might exist between those areas that received pesticides and those that did not. In order to secure information on the true effect of pesticides on the environment, tests will be conducted in aquariums and troughs inside buildings. Thus, it is hoped that differences in soil, light, water and other factors that affect the environment can be minimized.

Procedure: Aquarium and trough bottoms will be layered with homogenous soil mixtures, sprigged with aquatic plants and filled with water. Fish and aquatic insects will be introduced. Metabolism of the pesticide (endrin) will be followed by using 14C-tagged endrin.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0231, PRELIMINARY STUDIES ON ENDRIN AND OTHER PESTICIDE UPTAKES BY FINGERLING CHANNEL CATFISH

R.L. ARGYLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Marion, Alabama* 36756

Pesticides have been found in the flesh of channel catfish raised for sport and food, and in some instances these chemicals have been attributed to seriously injuring or even killing fingerling and large fish. Pesticides that contaminate these fish can come from the water supply, soil, feed, and air (wind borne). Studies will be conducted in pools and aquariums to determine the effect that each pesticide source has on the fish. By conducting these studies in pools and aquariums using pesticide-free water, by feeding purified diets, and by using known amounts of the pure form of pesticide, variables and interactions may be avoided that complicate data interpretations. Thus, these findings may be used in designing studies in near-natural situations and interpreting the results.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0232, PESTICIDES RESEARCH

T.R. MERRELL, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Auke Bay, Alaska* 99821

Our pesticide studies include two separate programs: One, the macro-invertebrate fauna of streams in Southeast Alaska are being studied to determine the ecological relationships between organisms and the seasonal abundance of dominant forms. The results will be used to predict effects of pesticides on stream fauna in the watersheds of similar streams in Southeast Alaska. The role of the invertebrate fauna in the diet of resident fishes is also being investigated.

Two, DDT residues in freshwater fish tissue is routinely monitored. Analyses of specimens collected from major river systems in the state show wide-spread contamination by DDT in many areas of Alaska. Fishes collected from the streams near population centers on military installations contain higher concentrations of DDT, DDD, and DDE than fishes from other parts of the state.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0233, THE OCCURRENCE OF PESTICIDE RESIDUES IN THE LOWER BRISBANE RIVER AND IN THE TISSUES OF ESTUARINE ANIMALS

J.M. THOMSON, Univ. of Queensland, *Saint Lucia, Brisbane, Australia*

Objective of Project: Testing tolerance levels of various species to pesticides and to compare this with the levels to which they are exposed.

Description of Project: Routine sampling at selected stations and testing for presence of commoner pesticides. Aquarium testing of lethal levels and observations on sublethal effects.

Address for Correspondence: Zoology Department, University of Queensland, St. Lucia. QLD. 4067

SUPPORTED BY University of Queensland - Brisbane, Aust.

1.0234, EFFECTS OF PESTICIDES ON AQUATIC ANIMALS IN THE ESTUARINE AND MARINE ENVIRONMENTS

R.D. EARNEST, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Belvedere, California* 94920

This study is a continuing effort in deriving median tolerance limits (TLm) of estuarine fishes to a variety of pesticides and combinations of pesticides. Static testing conditions will yield TLms for 24-96 hr intervals and continuous-flow conditions will be used for exposures as long as 30 days. The tests will include standard and varied conditions of temperature and water quality.

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1. PESTICIDE RESIDUES AND AQUATIC ENVIRONMENTS

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0235, CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS

W. GRIFFITH, State Dept. of Fish & Game, *Sacramento, California* 95819

Study Objectives: 1. Promote the development of pesticide use practices and pesticide regulation to adequately safeguard fish and wildlife and their environment. 2. Field test for toxicity and hazard the pesticides that appear to have the greatest potential for fish and wildlife damage.

Job Objectives: To evaluate those fish and wildlife pesticide problems and relationships that are currently of greatest concern to the Department. Concern is based on potential hazard to wild animals of certain experimental pesticides and pesticides used in operational pest control programs. The investigations are aimed primarily at: 1. developing information regarding the hazard of these chemicals under field conditions, and 2. developing a guide for establishing adequate safeguards for fish and wildlife. Special attention will be given to the hazards to game and nongame species created by the organic phosphates in cotton culture, and polychlorinated biphenyls (PCB) in eggs of raptors and water associated birds.

Procedures: (a) Evaluate the hazard of mercurial seed dressings to birds. A survey will be made to determine the amounts of the different mercurials being used in California. An assessment will be made of the comparative hazard of alkyl mercury seed dressing and other types of mercury seed dressings. Caged pheasants will be fed grain treated with alkyl mercury and another type of mercury fungicide to determine the effect on the test animals and the amount and type of mercury accumulated in tissues. Pheasants will be collected in areas where alkyl mercury and other mercury seed dressings have been used extensively over a period of years. The birds will be examined for gross pathology and tissues analyzed for mercury content. (b) Evaluate the effects on nontarget wildlife of Diphacin, and Endrin treated conifer and brush seeds in both field and forest rodent control programs.

The experimental application of the anticoagulant Diphacin for ground squirrel control may also be carried out in one or more of these by agricultural agencies. Evaluation of side effects of these experimental applications and other suitable tests will be made.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0236, PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM)

H.C. DAVIS, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Milford, Connecticut* 06460

The development of routine methods for rearing bivalve larvae has enabled us to determine the effect of various ecological factors on larvae of the American oyster, Crassostrea virginica, and the hard clam, Mercenaria mercenaria. Studies have been made of the effect of the type and quantity of food, salinity, temperature, turbidity, pH, and of various pesticides and detergents on embryonic development and on growth of the larvae of these two species. In some studies we have observed the combined effect of varying two or more of these factors simultaneously.

We are currently experimenting to determine the pH range for spawning of oysters and the effect of the pH at spawning on viability of the sperm and eggs. We are also currently studying the effect of keeping oysters at lowered salinities, during gonad development and spawning, on subsequent embryonic development and larval growth at different salinities. We expect to soon have methods developed for studying the behavior of larvae and the effect of light, gravity, temperature, salinity and currents on the behavior of larvae of different ages and sizes. Such studies are urgently needed to develop an informational basis for field work on distribution of larvae.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0237, RESEARCH STUDY ON THE EFFECTS OF POLLUTION ON SUB-TROPICAL FISH AND CRUSTACEANS

W.R. COURTNEY, Aquatic Sciences Incorporated, *Boca Raton, Florida* 33432 (14-12-532)

Description: This project will utilize the output of an established culture facility to determine the synergistic sublethal effects of temperature, oxygen, salinity, and a chlorinated hydrocarbon on the development of selected warm-temperate and subtropical species of fishes and crustaceans. The experimental species have been chosen because they represent forms which occupy sub-tropical fresh, brackish, or marine waters for all or part of their life histories, such waters and specific habitats being subject to several forms of potential environmental toxicants, their real or potential economic values as sports species, and their adaptability to being cultured with success in the laboratory.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0238, PESTICIDE MONITORING PROGRAM

P.A. BUTLER, U.S. Dept. of Commerce, Natl. Oceanic & Atmos. Admin., *Gulf Breeze, Florida* 32561

Cooperative program involving 15 private, state and federal laboratories who collect duplicate samples of mollusks from approximately 175 estuarine stations on Atlantic, Gulf and Pacific coasts at monthly intervals. Program initiated 1965, proposed to continue until 1969; 1500 analyses completed September 1965. Samples are sent to the Gulf Breeze Laboratory for pesticide residue analysis. Eastern oyster is chief bioassay animal, also used Mya arenaria, Mercenaria mercenaria, Ostrea luria, Crassostrea gigas and some fish species. Each sample is screened for Aldrin, BHC, Dieldrin, DDD, DDE, DDT, Endrin, Heptachlor, Heptachlor epoxide, Lindane and Methoxychlor. Analyses are made wiith electron capture gas-liquid chromatography techniques.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0239, ENZYME SYSTEMS OF ESTUARINE ORGANISMS

D.L. COPPAGE, U.S. Dept. of Commerce, Natl. Oceanic & Atmos. Admin., *Gulf Breeze, Florida* 32561

Two of the major classes of pesticides - the organic phosphates and the carbamates - are toxic to animals because they inhibit the enzyme acetylcholinesterase (AChE), which is essential to normal nerve impulse transmission. By assaying the AChE activity in nerve tissue of aquatic animals, pollution of the estuarine environment by these chemicals can be detected before deaths occur and at levels far below those which can be detected by present analytical techniques.

We will establish normal enzyme levels for selected vertebrate and invertebrate species, and conduct periodic sampling and assay. Lowered enzyme activity in one or more species will be indicative of pollution. We will also expose various fishes and invertebrates to commonly used pesticides to study degree of AChE inhibition and time necessary for recovery. An investigation of the effects of lowered enzyme levels on estuarine fauna will be conducted.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0240, BEHAVIOR OF ESTUARINE ANIMALS

D.J. HANSEN, U.S. Dept. of Commerce, Natl. Oceanic & Atmos. Admin., *Gulf Breeze, Florida* 32561

Objective: Determine the effects of pesticides on the behavior and physiological tolerances of estuarine animals.

Procedures: A. Using apparatus in which a gradient of pesticide concentrations can be established, the ability of selected mollusks, crustaceans and fish to sense and avoid pesticides will be tested. B. Animals will be exposed to pesticide concentrations that they cannot sense and avoid, and the alteration of behavior and physiological tolerances will be determined.

1. Alteration of preferences will be studied in salinity and temperature gradients. 2. After exposure to pesticides, the selected animals will be subjected to extremes of salinity, tem-

determined. Measurements of radioactivity in edible portions of the body and in mesentery fat will be used to reflect dieldrin levels present.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0248, ENZYME AND TISSUE ALTERATIONS IN FISH - A MEASURE OF WATER QUALITY

D.E. HINTON, Univ. of Louisville, School of Medicine, *Louisville, Kentucky* 40202

Microanatomy, enzyme histochemistry, and pathology of common species of freshwater fish will be studied to determine alterations occurring in fish found in polluted streams and rivers. Histopathological changes that occur under polluted conditions are to be described and quantified using standard techniques, i.e., Weibel's point count method. Primary attention will be directed toward detection of alteration in gills, brain liver and kidney. Correlation of laboratory experiments involving chlorinated hydrocarbon pesticides and heavy metals as well as field collected material will be performed to assess the changes brought about by these toxins.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0249, EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS

D.D. CULLEY, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01460)

OBJECTIVE: Produce insecticide-resistant strains of mosquitofish for the purpose of determining cross-resistance and susceptibility patterns, and environmental requirements of resistant fish.

APPROACH: Each of three groups of mosquitofish will be subjected to a high concentration of one insecticide (parathion, toxaphene, or DDT) in the laboratory until most fish are killed. Survivors will be allowed to breed and progeny returned for another treatment. This process will be continued until resistance develops. Cross-resistance and susceptibility patterns will be identified by comparing results of bioassy tests conducted with selected strains and the parental population, using insecticides to which the fish have never been exposed. Tests will be conducted to determine if selection for resistance affects growth, reproduction, survival, susceptibility to disease or parasites, or environmental requirements.

PROGRESS: The survivors of three populations of mosquitofish, exposed to a different insecticide, were stocked in separate ponds for reproduction. The offspring were collected and exposed to the same insecticide as their parents until the populations were reduced by 90 percent. Again, the survivors were stocked in new ponds (without fish) for reproduction. During 1969, each of the three populations was selected in the same manner through four generations. Just prior to bringing the F(4) groups to the lab to determine if any resistance had developed, heavy rains flooded the ponds and the treated fish moved freely from pond to pond.

SUPPORTED BY Louisiana State Government - Baton Rouge

1.0250, PESTICIDE CONTAMINATION OF ENVIRONMENT

L.D. NEWSOM, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01204)

OBJECTIVE: Determine the extent to which the environment is contaminated and to develop a continuing monitoring system. Develop more satisfactory analytical techniques and methodology than those which presently exist for residues of some insecticides. Furnish pesticide analytical services to cooperating departments.

APPROACH: Amounts of insecticide residues currently present will be determined in representative samples of soil, water, bottom sediments, aquatic and terrestrial animals, and plants from five areas differing in ecology and land use. Particular attention will be devoted to developing more satisfactory techniques for determining levels of organophosphorus and carbamate residues as well as any new materials which come into widespread use. Capability for analyses can be done for all cooperating departments.

PROGRESS: Residues in fish samples from 5 monitoring sites established 3 years ago continued to reflect pesticide use. Endrin residues had virtually disappeared in fish from Bayou Chevreuil in the sugarcane area, reflecting change from endrin to guthion for control of sugarcane borer. DDT residues still high in fish from streams draining cotton producing areas. Sacks used for treated seed rice or seed corn and used second-hand for sacking feed found to be an important source of contamination of milk. Coastal bermuda forage produced on cotton farms proved to be a major source of DDT contamination; rice bran of dieldrin in milk. Residues of chlorinated hydrocarbon insecticides still ubiquitous in all species of wildlife examined. Continued work on chlorinated hydrocarbons in the Louisiana environment. Emphasis has been on residues in milk. A new and heretofore unsuspected source of contamination was discovered. Studies of residues in commercial catfish are in progress.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0251, TOXICITY OF POLLUTANTS TO STRIPED BASS

J.S. HUGHES, State Wildlife & Fish Comm., *Baton Rouge, Louisiana* 70804

Objectives: (1) To determine the toxicity of pollutants to various sizes of striped bass.

Procedures: Striped bass ranging in size from fry to six inches in length will be used for these toxicity studies. Standard bioassay techniques will be followed. Dilution water will be from Bayou DeSiard, a lake adjacent to the laboratory. The water quality will be checked before each series of tests. Bioassays will be run at 22 degrees Centigrade.

Pollutants that will be included in this study are paper mill wastes; oil well effluents; wastes from sugar cane mills; rotenone; antimycin A; and pesticides, such as, 2,4-D, 2,4,5-T, silvex, endothal, diquat, dylox, methyl parathion, DDT, and endrin.

Total survival, total mortality and the TLm will be reported for 24, 48, 72, and 96 hours.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0252, EFFECTS OF CHRONIC SUBLETHAL DOSAGES OF DDT ON THE SWIMMING PERFORMANCE OF ATLANTIC SALMON PARR

J.D. MCNEISH, Univ. of Maine, Graduate School, *Orono, Maine* 04473

The effects of sublethal dosages of DDT on the swimming performance of Atlantic Salmon parr is being investigated. Performance is measured by the Burrows stamina tunnel which is housed in facilities provided by Craig Brook National Fish Hatchery. The project was initiated July, 1967.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0253, THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS

C.F. COLE, Univ. of Massachusetts, School of Agriculture, *Amherst, Massachusetts* 01002

Saltmarshes and their meandering estuarine streams too often have been considered a biological wasteland and public apathy has allowed these areas to become targets of developers of waterfront properties and uncontrolled use of pesticides. The estuarine environment is breeding ground for commercial and sport fishes and little data are available concerning the influence of pesticides upon their general life history. A program was recently established to obtain detailed data on the interaction of pesticides in the estuarine area of the Weweantic River on the northwestern shore of Buzzards Bay. The pesticide investigation will study the possibility of acute toxic conditions occurring from single instances of pesticide application. As the occurrence of parathion in the estuary is ephemeral at most, and, as parathion is one of the major insecticides now used on cranberry bogs, this study is of major significance. The objectives of this project are to study the larval blackback flounder mortality under controlled perature and other stresses to determine if sensitivity has been changed. 3. Schooling fish will be exposed to pesticides to determine if there are changes in schooling patterns.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0241, LABORATORY BIOASSAYS

J.I. LOWE, U.S. Dept. of Commerce, Natl. Oceanic & Atmos. Admin., *Gulf Breeze, Florida* 32561

The primary objectives of the subject project are: (1) determination of the acute toxic levels of pesticides to representative marine species, and (2) investigation of possible adverse effects of prolonged exposure of marine animals to sublethal concentrations of the common pesticides.

Short-term (96-hour or less) toxicity tests are conducted in the laboratory under controlled conditions. Most of the tests are conducted in constant-flow seawater systems using oysters, shrimp, and marine fish as bioassay animals. These acute toxicity tests will be a continuing function of the project as new chemicals are received for evaluation.

Long-term experiments (3 to 6 months duration) involving the chronic exposure of marine animals to sublethal concentrations of selected pesticides will be conducted when the efforts and results seem justified.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0242, PHYSIOLOGY OF ESTUARINE ORGANISMS

D.W. NIMMO, U.S. Dept. of Commerce, Natl. Oceanic & Atmos. Admin., *Gulf Breeze, Florida* 32561

The purpose of this research is to determine the physiological effects of low levels of pesticides on estuarine fauna. At present, the research is divided into two areas of interest: (1) the effects of DDT on protein metabolism in shrimp and (2) the kinetics and deposition of C14-labeled pesticides in the tissues of shrimp.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0243, EFFECTS OF PESTICIDES ON MARINE ANIMALS

C.E. LANE, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149

Description: Lactic dehydrogenase (LDH) is one of the intracellular enzymes that increases in serum when tissue cells are destroyed by pathology or injury. Recent progress in clinical chemistry has made it possible to identify the source of abnormal concentrations of several of the isoenzymes of LDH with some precision, taking advantage of their different electrophoretic mobilities and sensitivity to heat inactivation. Using these established clinical procedures, or micromodifications suitable for the small amount of blood collected from the Molly, it is proposed to identify the organ system most affected by chronic exposure to Dieldrin. This determination will then be confirmed by direct needle - biopsy. Using a solid sample injecting port we should have the capability to determine Dieldrin and its metabolites in untreated tissue samples. The uncertainities introduced by the usual extraction, concentration, and transfer procedures will be eliminated. These data should establish pathways and help to explain the mortality caused by exposure to dilute solutions of Dieldrin.

It is also proposed to explore the distribution of tissue and serum enzyme activities in the offspring of our three populations of Poecilia Latipinna with differing sensitivities to Dieldrin.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0244, EFFECTS OF PESTICIDES ON MARINE ANIMALS

C.E. LANE, Univ. of Miami, School of Marine Science, *Miami, Florida* 33149

Molting in Crustacea involves the coordinated activity of many independent biochemical mechanisms. Since post-molt 'Penaeus duorarum' apparently absorb dieldrin from sea water at different rates from pre- molt animals, it is proposed to measure absorption and distribution of dieldrin in all stages of the molt cycle in these animals. Using various stages of the life cycle of 'P. duorarum', made available to us by the experimental shrimp-rearing program of the Fisheries Division, we propose to study effects of dieldrin on growth, larval development and metamorphosis, molting and metabolism. The effects of dieldrin on various developmental stages of the sea urchins 'Echinometra' and 'Lytechinus' will be investigated.

SUPPORTED BY U.S. Environ. Protect. Agency - W.Q.O.

1.0245, RELATIONSHIPS BETWEEN SUB-LETHAL PESTICIDES AND REPRODUCTION AND BEHAVIOR OF FISHES

J.P. KERR, Univ. of Georgia, Graduate School, *Athens, Georgia* 30601

This study proposes to examine the possible effects on the reproductive capacity in a few fish species of periodic and continuous exposures to sublethal concentrations of DDT and perhaps other pesticides.

Objectives: To improve knowledge on the reproductive capacity and behavior of certain fishes, especially the guppy; to assess in laboratory studies the possible effects of chronic and periodic sublethal exposures to pesticides, especially DDT and its derivatives, on the reproductive capacity of fishes, by exposing them to various pesticide concentrations and then noting changes in: (a) reproductive behavior patterns (primary emphasis) (b) general behavior patterns (c) rate of sexual maturation (d) gametogensis (e) gamete viability and fertilization.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0246, PHYSICAL AND CHEMICAL FACTORS AFFECTING FISH

J.L. HAMELINK, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01720)

OBJECTIVE: Study effect and utilization of heated effluents from power plants on fish. Improve farm pond management for recreational and commercial fisheries. Elucidate the dynamics of synthetic organic compounds (eg. pesticides) in aquatic ecosystems.

APPROACH: Channel catfish will be cultured in cages placed in heated effluents and farm ponds to assess the biological and economic potential for the industry in Indiana. Several farm ponds will be managed for field studies concerned with farm chemicals, dynamics of fish populations, fish production and commercial fish culture. Studies into the dynamics of synthetic organic compounds in aquatic ecosystems will be continued once the proper laboratory and field facilities are developed. Initial interest will be confined to the physical factors of solubility and adsorbtion which are believed to control the dynamics of these compounds in lakes.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0247, CONTAMINATION OF CHANNEL CATFISH WITH DIELDRIN FROM AGRICULTURAL RUNOFF

R.V. BULKLEY, Iowa State University, School of Science, *Ames, Iowa* 50010

The proposed research will involve field and laboratory investigation on the pathways by which channel catfish take up the chlorinated hydrocarbon dieldrin from waters draining agricultural areas and the rate elimination of this chemical from the fish after exposure. Levels of dieldrin will be compared in fish and water under varying conditions of runoff and turbidity.

Field investigations will consist of regular collection of adult and young fish and water from a typical river draining corn land where intensive use of dieldrin has been made in past years. Quantitative analysis of dieldrin will be made from selected tissues and water using gas chromatographic techniques.

Laboratory investigations will center on determining the pathway by which catfish take up the pesticide and length of retention time in the body after ingestion with food and after absorption through the gill membranes. C-14 Dieldrin will be introduced into aquarium water and fed to fish. Variations in uptake and retention between adult and juvenile catfish will be laboratory conditions; to study a comparative larval mortality in three widely separated geographical areas; to conduct bioassay studies which will delimit tolerance levels, especially for blackback larval flounder; and to conduct a more critical study of the occurrence of area specificity, as evidenced in previous chromatographic patterns.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0254, PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES

C.F. COLE, Univ. of Massachusetts, School of Agriculture, *Amherst, Massachusetts* 01002

Effects of chronic, low-level pesticide exposures on eggs and larvae of the winter flounder (Pseudopleuronectes americanus, Walbaum) are being evaluated. A previous segment of this project examined chlorinated hydrocarbon residue levels in winter flounder from the Weweantic River estuary, a small tidal tributary of Buzzards Bay, Massachusetts. The effects of these residue levels on the reproductive success of the flounder using this estuary as spawning and nursery grounds is of particular concern. Field investigations have demonstrated that certain insecticides (DDT and dieldrin) commonly used in the watershed by cranberry culturing and mosquito control programs are present in the flounder; heptachlor is also present but its source is unknown. Increasing concentrations of these insecticides were noted in flounder ovaries during the months prior to spawning. Laboratory investigations are presently underway to determine what concentration ranges of the insecticides residues in gonadal tissues generate measurably adverse effects during reproduction. The survival of eggs, larvae, and juveniles spawned from dosed adults is being followed and the reproductive success is then to be evaluated in light of concentrations from gonads of similarly treated adults. Gas-liquid chromatography is the major analytical tool. The flounder dosing and rearing experiments are being undertaken at the Bureau of Sport Fish and Wildlife Laboraory, Narragansett, Rhode Island.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0255, FACTORS AFFECTING PESTICIDE TOXICITY

S.D. MURPHY, Harvard University, School of Public Health, *Boston, Massachusetts* 02115

The long term goal of the proposed research is to contribute to the understanding of relationships between metabolism and toxicity of pesticides. Major emphasis will be placed on studies of species comparisons of metabolic and toxic interactions of organophosphorus insecticides with other chemicals and drugs. Species to be studied include members of 4 classes of vertebrates; mammals, birds, fish and amphibians. Chemicals which inhibit tissue hydrolases or which induce or inhibit microsomal enzymes that are involved in the metabolism of phosphorothioates will be studied to obtain time and dose response relationships for both effects on metabolism and effects on toxic interactions in intact animals. A search for a possible physiologic significance for the potent carboxylesterase inhibiting properties of some phosphate insecticides will be made. Newer insecticides which have relatively low acute toxicity will be studied to determine their potential to produce subtle effects that are unrelated to the well known anticholinesterase action of orgnophosphates. It is felt that this research will contribute to the understanding and predictability of adverse effects of pesticides in man and other desirable species. An indirect, but important objective will be to provide a stimulating research program as a base from which graduate students can develop thesis research projects.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

1.0256, RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES

R. REINERT, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Ann Arbor, Michigan* 48107

A program to follow the buildup of insecticides in lake trout and coho salmon that have recently been introduced into Lakes Michigan and Superior. The eggs and fry will be studied before the fishes are introduced into the lakes and then as these populations develop they will be sampled periodically. When the fishes reach maturity their eggs and progeny will be examined for insecticide levels.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1D. FOOD CHAINS

1.0257, FIELD STUDIES OF PESTICIDE EFFECTS ON FISHES

M.E. BENDER, Univ. of Michigan, School of Public Health, *Ann Arbor, Michigan* 48104

Description: The objective of this project is to establish acceptable exposure levels of methoxychlor for fish and other aquatic organisms. This objective will be reached by determining the effect of long-term exposure to sub-lethal levels of methoxychlor by laboratory bioassays and in natural stream conditions. Effect on fish growth will be established in the laboratory with bioassays on two species of fish. Effects on fecundity, survival and production of fish populations and production of benthic organisms will be established from studies in controlled stream environments.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0258, LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES

M.E. BENDER, Univ. of Michigan, School of Public Health, *Ann Arbor, Michigan* 48104

The long-term effects of parathion and endrin exposure to aquatic invertebrates are being studied under continuous flow conditions. Test organisms include: the stonefly Acroneuria, the caddis flies Hydropsyche and Chimarra, the dobsonfly Corydalus and crustaceans Asellus and Gammerus. Measurement of effects is being evaluated by: mortality rates, growth, time of molting, success of emergence and reproduction success of crustaceans.

The acute and chronic effects of the hydrolysis products of malathion, parathion, and sevin are also being studied.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0259, QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH

L.J. BRATZLER, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL03061)

OBJECTIVE: Determine the effect of the spawning process (period) on the quality of Coho salmon flesh. Determine the level of possible pesticide residues in Coho salmon flesh.

APPROACH: Flesh quality characteristics of Coho salmon prior to and during the spawning period will be studied. Such factors as muscle pigmentation change, muscle firmness, protein, fat, moisture, cooking shrink, and taste panel evaluation of aroma, flavor, and acceptance will be used to characterize flesh quality changes that may occur. The effect of freezing and frozen storage will be studied and would include such criteria as defrosting drip loss, rancidity measurements, cooking shrink, and taste panel evaluation. Pesticide determinations would be made on the fresh cooked fresh, frozen, frozen stored, and cooked frozen salmon. It is contemplated using salmon from three or four periods. These would include fish samples taken from Lake Michigan sometime prior to the normal spawning period as examples of first quality Coho salmon flesh. Samples would also be taken during the spawning period to obtain information relative to quality degradation that may occur due to the physiological process of spawning.

PROGRESS: Coho salmon (78) were obtained that presented 1968 spawning or post-spawning (A); 1969 pre-spawning (B); and 1969 spawning or post-spawning (C) periods. Taste panel scores were highest for B with little difference between A and C; females were scored higher than males. Peroxide values showed more relationship (negative) to taste panel scores than percent protein, fat, moisture, or fish size. DDT levels in uncooked whole salmon steaks ranged from 2.2-13.8 ppm and were 1.7-10.2 ppm in comparable cooked steaks. Trimmimg fatty regions from the steak reduced residues proportional to the amount of fat removed, but never exceeded 40%. Wide variation between individual samples made comparison of residues between pre-spawning and spawning fish impossible. Results for DDE and TDE showed similar variation.

SUPPORTED BY Michigan State Government - Lansing

1.0260, PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS

P.O. FROMM, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00122)

OBJECTIVE: Determine physiological cause of death in aquatic animals most susceptible to pollutants, establish the symptoms of sublethal amounts of pollutants. Identify responses which have value as diagnostic symptoms of pollution toxicity. Determine validity of findings in predicting population changes in habitats subjected to pollution.

APPROACH: Kinetics of surface binding of chromium to cells made and studies of metabolic respones of fish. Investigation of pathway(s) of excretion by fish of two radionuclides (Cr and I) permeability of fish skin.

PROGRESS: Studies using the isolated-perfused trout gill preparation have indicated that when perfused with Ringer solutions having sodium concentrations less than normal plasma levels there was a net uptake of sodium from the bath solution. Perfusion fluid sodium level and epinephrine both appear to control the rate of sodium uptake by isolated gills. Experiments with various inhibitors indicated that sodium uptake is an oxidative metabolism dependent and an ATP dependent system which may be independent of rate and pattern of fluid flow through the gill. In gills exposed to dieldrin, rotenone and MS-222 (tricainemethanesulfonate) flow rates in muL/min dropped significantly, whereas exposure to methoxychlor had no effect. Histological sections of india ink perfused gills exposed to these test chemicals have not yet been completely evaluated and results will be reported later. Studies of the effect of these same chemicals on sodium transport by isolated gills were made using flame photometric analytical procedures but the results were generally unsatisfactory. New studies using radiosodium and radioiodine labeled protein are now underway and reliable data should be obtained. Studies of the effect of ammonia on nitrogen excretion by intact fish have been terminated. When ambient ammonia was increased total-N and ammonia-N excretion decreased, excretion of urea remained relatively constant and the excretion of waste protein-N showed a slight increase. Some five per cent of the total waste-N excreted remained unidentified.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0261, BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH

H.E. JOHNSON, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL03078)

OBJECTIVE: Determine the effect of specific pesticides in varied combinations on the growth and reproduction of fish and fate and effect of pesticide residues in fish subjected to environmental stress. Identify the source of pesticide residues in selected inland water of Michigan.

APPROACH: Fish will be exposed to graded series of pesticide concentrations under continuous flow conditions to measure effects on gonad development, egg fertility, and embryo survival. Stress conditions (thermal, osmotic, and diet) will be superimposed on exposure conditions and effects evaluated by analysis of growth, pathology and reproductive success. Blood chemistry will be monitored as an indicator of residue mobilization.

PROGRESS: The analysis of coho salmon eggs from Lake Michigan and Lake Superior show only slight differences in DDT concentration between streams and between fish of different sizes. Abnormally high mortality of the fry from Lake Michigan sources indicated the fry absorbed toxic residues from their yolk sacs during the fourteenth week after fertilization. The data indicates pesticide residue concentration and mortality tend to decline during the later parts of the spawning run. The presences of residues which interfere with gas chromatographic analysis of DDT confounded the interpretation of the significance of pesticide residues to the mortality. A proportional diluter was developed and tested to provide chronic exposure of fish to sublethal concentrations of dieldrin in the study of pesticide effects on blood lipids. The role of blood lipids and their response to environmental change may be an important factor in the response of fish to pesticide toxicity.

SUPPORTED BY Michigan State Government - Lansing

1.0262, MAGNITUDE AND NATURE OF POLYCHLORINATED BIPHENYLS IN COHO SALMON

N.C. LEELING, Michigan State University, School of Agriculture, *East Lansing, Michigan* 48823

The proposed research plan involves laboratory investigations aimed at determining the amount of polychlorinated biphenyl (PCB) and terphenyl compounds present in Coho salmon from Lake Michigan and the chemical identity of each major component. The main approach will entail organic solvent extraction of salmon samples, column chromatographic separation of chlorinated components into a DDT-complex fraction and a PCB fraction and a gas chromatographic-mass spectrometric characterization of the individual components.

The data will provide an accurate determination of PCB residue levels and their composition in Coho salmon, thus permitting a rational interpretation of the significance of these compounds with respect to the fish.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0263, STREAM STUDIES TO DETERMINE TOXIC EFFECTS OF METHOXYCHLOR IN FISH POPULATIONS

J.W. MERNA, State Res. & Dev. Division, *Lansing, Michigan* 48926

Objective: To determine the effects of long-term exposure to sublethal level of methoxychlor on fish populations in experimental streams, especially on fecundity and reproduction of fathead minnows and yellow perch.

Procedure: The effect of methoxychlor on reproduction, growth, and production of fathead minnows and yellow perch will be measured in the experimental streams. To demonstrate effects on reproduction we will determine fecundity, deposition of eggs, size of eggs and hatching success in relation to concentration of methoxychlor. The determination of growth and production of fish will be based mainly on young-of-the- year during their first growing season. Production will be measured by survival and growth of the young-of-the-year plus growth of the adult brood stock.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0264, LABORATORY BIOASSAYS TO DETERMINE TOXIC EFFECS OF METHOXYCHLOR IN FISH

J.W. MERNA, State Res. & Dev. Division, *Lansing, Michigan* 48926

Objective: To determine lethal levels of methoxychlor, and effects of sublethal levels on growth and reproduction of fathead minnows and yellow perch in aquaria.

Procedure: Laboratory studies involve the use of four continuous flow bioassay units, with fathead minnows and yellow perch as test fish. We have fatheads in three units being dosed at 2.0, 1.0, 0.5, 0.25 and 0.125 micrograms 1. The unit containing perch is dosed at 10.0, 5.0, 2.5, 1.25 and 0.625 micrograms 1. We previously reported the 96-hour TL50 values of methoxychlor to be 7.5 micrograms/l for fathead minnows and 20 micrograms/l for perch. The effects of methoxychlor in the bioassay units will be determined by measuring growth of both species, and measuring success in spawning by the fatheads.

Schedule: This job is continuous throughout the year. Some of the individual tests have now been completed. Lethal levels have been established. We will soon terminate the first growth and reproduction segment consisting of two bioassay units with fathead minnows and one unit of perch. We will then initiate spawning in the third fathead unit. Two units will then be started with intermittent, rather than continuous, dosing.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0265, A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES

L.K. CUTKOMP, Univ. of Minnesota, School of Agriculture, *Saint Paul, Minnesota* 55101

Description: The overall objective is to be able to develop a detecting system for insecticide polluted water utilizing an enzyme assay. The experimentation will relate the effects of chlorinated hydrocarbons to their effect on fish. A secondary objective is to determine which tissues of fish are most sensitive when tested for ATPase enzyme activity and inhibition by a chlorinated hydrocarbon insecticide. This objective becomes important in interpreting the results in relation to physiological disturbances, symptoms, and mortality. The important enzyme adenosine triphosphatase, ATPase has been chosen because our present research shows it to be inhibited by the chlorinated hydrocarbon insecticides.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0266, MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR

L.K. CUTKOMP, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-17-047)

OBJECTIVE: Determine the effects of insecticides, particularly chlorinated hydrocarbons and pyrethrum on the enzyme systems, adenosine triphosphatase (ATPase) both in vitro and in vivo. The insecticidal effects and the ATPase enzyme activity will also be related to periodic (rhythmic) physiological events in the insect.

APPROACH: Accepted current biochemical determinations will be made of the ATPase enzyme system in nervous and muscle tissues of American cockroaches, honey bees and other insects. Known dilute concentrations of DDT, other chlorinated hydrocarbons and pyrethrum will be tested for specific inhibitory effects on the enzyme system. In addition, the specific activity of the enzyme system and insecticide sensitivity will be related to periodicity in the American cockroach, using established light and dark lighting regimes during a 24-hour day.

PROGRESS: Basic information on the activity of the ATPase enzyme system has been determined in muscle and nerve cords of American cockroaches. The inhibition of the enzyme has been determined by in vitro and in vivo experiments. Alpha and gamma chlordane gave much greater inhibition of the ATPase enzyme in vitro than in vivo. When roaches were injected the maximum inhibition was about 33% in roach muscle compared to over 85% inhibition on the isolated enzyme system. DDT at 1 part per million also inhibits Mg ATPase. One aspect of research pertains to development of a tissue enzyme assay for chlorinated hydrocarbon insecticides in fish. Five tissues in bluegill fish have been tested for ATPase activity and sensitivity to p,p'DDT. The highest enzyme activity is greatest in kidney and brain, but the greatest enzyme sensitivity to DDT occurred in muscle of fish as well as in cockroach, honeybee, and rabbit. Muscle ATPase from lake trout muscle was also more sensitive to DDT when compared to brain ATPase. The percent of Na -K ATPase (ouabain inhibited) in relation to total ATPase was as follows: brain, 56.3%; kidney, 53.5%, liver, about 11%; muscle 7.4%; testis, 9.9%. A comparison of effectiveness of insecticides on corn rootworm adults has indicated increased resistance of insects to diazinon and phorate when compared to determinations in 1968. Some rhythmicity studies on oxygen consumption have been carried out with Tribolium confusum.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0267, THE UPTAKE OF AND BIOLOGICAL RESPONSES TO AROCLORS IN CHANNEL CATFISH

J.G. ARMSTRONG, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Doses of Aroclors 1232, 1248, 1254, and 1260 will be individually administered daily by diet to groups of immature channel catfish. After 6 months, fish from each treatment will be examined for histopathology and for changes in blood serum constituents. Skeletal weights and thyroid activity will be estimated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0268, SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA - CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES

J.G. ARMSTRONG, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The purpose of this work unit is to screen carbamates, fungicides, insect repellents, herbicides and polychloro biphenyls for possible teratogenic effects.

The mosquitofish, 'Gambusia affinis' will be used as a test animal. Groups of mosquitofish containing both male and female subjects will be fed formulations of the above compounds through their diet both alone and in combination. Whole, cleared specimens of the resulting progeny will be examined for anomalies and histological sections will be evaluated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0269, PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS

B.F. GRANT, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Adult rainbow trout will be exposed to endrin or dieldrin in the diet for 6 months. On the day of autopsy, the fish will be forced to swim for 1 hr. The above constituents are to be studied. Serum Na, K, Ca, Mg, Cl, PO4, osmolality, NPN, total protein, electrophoretic analysis, cholesterol, creatinine, total amino acids, cortisol, lactate, glucose, and liver glycogen of the rainbow trout are to be studied.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0270, EFFECTS ON THE SPERMIATION RESPONSE OF GOLDFISH AFTER EXPOSURE TO SELECTED PESTICIDES

B.F. GRANT, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Adult male goldfish with developed testes will be injected with the spermiation gonadotrophin isolated by Sephadex G-100 gel filtration to induce the 24-hr spermiation response after having received six days exposure to various selected pesticides by bath in a metered continuous- flow system. A range of four half-log increments of dosage are given. The response in treated fish will be compared to the response of controls.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0271, NERVE IMPULSE TRANSMISSION CHARACTERISTICS OF ISOLATED FISH-NERVE PREPARATIONS PERFUSED WITH PHYSIOLOGICAL LEVELS OF SELECTED PESTICIDES

B.F. GRANT, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Pilot studies on intact and isolated nerve preparations are carried out using the Beckman Dynagraph II. Thresholds, action potentials, accommodation, inhibition, refractory periods, and other associated neurological phenomena in the presence of encountered levels of certain organochlorine toxicants in trout, catfish and tilapia in nature are estimated. Definitive work will follow as indicated by evaluation of preliminary studies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0272, THYROIDAL I125 UPTAKE IN IMMATURE CHANNEL CATFISH FOLLOWING EXPOSURE TO SELECTED TOXICANTS

B.F. GRANT, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Immature channel catfish will be exposed to doses of toxicants such as insecticides and polychlorobiphenyl compounds with a continuous-flow dilutor. Survival conditions are kept optimal with respect to oxygen and waste accumulation. Organochlorine residues in the water and in the catfish are estimated when appropriate. After 30 days exposure, the fish are injected, 1 ul (0.01 uc)/gm, intraperitoneally with I125. The ability of the thyroid to fix radioiodine in 72 hr will be evaluated.

1. PESTICIDE RESIDUES AND AQUATIC ENVIRONMENTS

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0273, SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS

F.B. GRANT, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The serum of cutthroat trout will be studied during extended bath and feed treatments carried out at Jackson, Wyoming. The parameters to be measured are: Na, K, Ca, Mg, Cl, HCO3 (equilibrated with 5% CO2), NPN, urea, uric acid, creatinine, creatine, amino acids, cholesterol, total protein, and osmolality.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0274, COMPARISON OF METHODS USED TO MEASURE ESTERASE ACTIVITY. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS

J.W. HOGAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

This work unit will attempt to correlate results of esterase activity measurements obtained by two colorimetric methods and by a manometric method. Brain tissue from three species of fish, cutthroat trout (Salmo clarki Richardson), bluegill sunfish (Lepomis macrochirus Rafinesque), and channel catfish (Ictalurus punctatus Walbaum) will be analyzed for acetylcholinesterase levels. The entire brain will be removed from the fish, homogenized in deionized water, divided into aliquots, and diluted with the appropriate buffer. At least triplicate samples of each homogenate will be analyzed by all methods. Also, effects of storage by freezing will be studied. In vitro inhibition will be determined. Samples of homogenate will be incubated with various anticholinesterase agents and the resultant decrease in acetylcholinesterase activity will be measured. Brains removed from fish which have been exposed to various anticholinesterase agents will be analyzed to correlate in vivo inhibition. All results will be analyzed statistically to determine if there are any significant differences.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0275, SEASONAL CHANGES IN ESTERASE ACTIVITY IN FISH AND INVERTEBRATES. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS

J.W. HOGAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Samples of adult bluegill and at least one species of aquatic invertebrate will be collected at monthly intervals and assayed for acetylcholinesterase activity. The initial study will continue for at least one year. If statistically significant changes in esterase activity are found to be correlated with sampling date the study will be extended for a second year and may be expanded to include additional species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0276, CHARACTERIZATION OF ESTERASE(S) PRESENT IN FISH BLOOD

J.W. HOGAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Initially, a suitable method for collecting uncontaminated fish blood will be selected. The various types of esterase(s) present in different fractions of blood will be characterized. This characterization will probably include such parameters as optimum substrate, optimum substrate level, optimum enzyme level, specific activity, effect of divalent cations, etc. Ideally, at least two species will be studied at the same time so that comparisons can be made. When the basic parameters are known the effect of various anticholinesterase agents will be studied. Initial studies will be in vitro, however, in vivo studies will be incorporated at a later date. In vivo studies will be designed to take advantage of the fact that the effect of a pesticide on individual specimens can be followed in the blood without sacrificing the animal.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0277, SCREENING OF PESTICIDES AGAINST FISH AT COLUMBIA MISSOURI

H.D. KENNEDY, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objective of the work is to determine relative acute toxicity indices of a variety of pesticides, and combinations of pesticides, tested against several species of fish, under both static and continuous flow conditions of exposure. The work will involve determining TL 50 values for various periods of exposure under standard conditions of temperature and water quality.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0278, THE INFLUENCES OF ENVIRONMENTAL CONDITIONS ON THE TOXICITY OF PESTICIDES

H.D. KENNEDY, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objective of the work is to investigate the effects of variations in bioassay conditions on the toxicity of pesticides to fish. Controlled variation of temperature, water quality, mass-volume relationships, and other factors will provide information concerning the influence of such factors on fish-pesticide relationships.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0279, THE SUSCEPTIBILITY OF VARIOUS LIFE STAGES OF FRESHWATER FISHES TO THREE TOXICANTS

H.D. KENNEDY, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

This work attempts to evaluate differences in the uptake activity of various pesticides among various sizes of fish from egg to adult. Representatives of the salmonids, ictalurids, centrarchids, and other families will be studied. We will expose fish of particular lots or strains in size categories between 1-80 gm to antimycin, chlordane, and Abate 4-E in static or flow-through bioassay test systems to determine relative toxicity indices. Tests will be conducted under standard as well as altered conditions of temperature and water quality.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0280, RELATIVE SUSCEPTIBILITIES OF FISH FAMILIES TO HERBICIDES

H.D. KENNEDY, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

This study attempts to evaluate phylogenetic differences in the susceptibility of the families Salmonidae, Cyprinidae, Ictaluridae, Centrarchidae, and Percidae to herbicides. Bioassay methods with standard and altered conditions of temperature and water quality under both static and flow-through systems will be used to determine 24 and 96-hr TL sub 50 values.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0281, INVESTIGATION OF STRESS-INDUCED MOBILIZATION OF INSECTICIDE RESIDUES - CHRONIC TOXICITY OF PESTICIDES TO FISH

K.J. MACEK, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objectives of the work are to determine if mobilization of insecticide residues, similar to that reported for higher vertebrates, does occur in fish during periods of stress, what the effects of such mobilization are, and what organs are involved in producing such effects. The work will involve feeding DDT and dieldrin to fingerling chinook salmon for approximately 200 days. After the exposure period, the fish will be subjected to several combinations of degrees of starvation and temperature fluctuations. Residue concentrations will be measured in whole fish and various organs and tissues to determine amounts accumulated and metabolized during exposure, as well as the activity of such residues during stress.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0282, CHRONIC EFFECTS OF DURSBAN ON WARM-WATER FISH

K.J. MACEK, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Objective: To assess the chronic effects from contact exposure treatments of pesticides to warm-water fish in six one-tenth acre ponds at Columbia, Missouri. The fish will be exposed to various treatments of different concentrations. Samples of fish will be taken at predetermined times for chemical residue analysis, stomach samples, and for histopathological examination. Measurement of fish growth, survival, and reproduction will be made. Effects on other factors of the pond ecosystem: aquatic invertebrates, vegetation, plankton, and water quality will also be measured.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0283, EFFECTS OF PARATHION AND MALATHION ON WARM-WATER FISH PONDS

K.J. MACEK, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Objective: To assess the chronic effects of the insecticides malathion and parathion, alone and in combination, on the ecology of warm-water fish ponds. The ponds will be treated at approximately 28 day intervals with 0.5 lbs/acre of either or both of the insecticides. Chemical analysis will be performed on fish, water, mud and vegetation to measure insecticide residues. Effects on cholinesterase activity, histology, growth, feeding habits, and survival of green sunfish and channel catfish will be evaluated. Changes in structure of the invertebrate populations will be measured.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0284, UPTAKE, PERSISTENCE AND METABOLITES OF SEVIN BY CHANNEL CATFISH

K.J. MACEK, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objectives of this research are to determine the kinetics of uptake, metabolism and distribution of Sevin. Adult channel catfish are exposed to 14C Sevin either by continuous flow bath or daily in their feed. Two treatments levels in duplicate are used for bath and feed exposures. Rates of accumulation and total amounts of Sevin and it's metabolites are monitored at 3, 7, 14, 28, and 56 days. Chemical distribution and half life will be evaluated at the end of the study.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0285, CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES

F.L. MAYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

This work is a continuing program for deriving toxicities of various pesticides against freshwater fishes in a flowing-water system. The exposure interval may be as brief as 96 hr, but mostly dosages are adjusted to allow the test to go 21-30 days or, in some instances, longer. Tests will be conducted under standard, as well as varied, conditions of temperature and water quality.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0286, EARLY SQUAMATION OF BLUEGILL (LEPOMIS MACROCHIRUS) AND FATHEAD MINNOWS (PIMEPHALES PROMELAS) EXPOSED TO AROCLORS

F.L. MAYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Patterns of early scale development will be studied on bluegill and fathead minnows receiving selected levels of the Aroclors 1242 and 1254. Chronic exposures will be given by bath. The fish samples will be sampled at pre-determined intervals, cleared with a 10% solution of concentrated hydrogen peroxide, stained with alizarin red, and their squamation compared with known patterns of development.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0287, CHRONIC TOXICITY OF PESTICIDES TO FISH

F.L. MAYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The effect of Aroclors 1242 and 1254 on residual storage of DDT and dieldrin in bluegill, channel catfish, and rainbow trout will be determined. Fish will be treated via food or bath for four weeks. Liver detoxifying enzyme activities will be determined at selected intervals. Fish will be killed and analyzed for organochlorine residues at 0, 1, 3, 7, 14, and 28-day intervals.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0288, PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS

P.M. MEHRLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Rainbow trout will be exposed to six months of DDT, dieldrin, and a combination of the two and subjected to 4 weeks of forced swimming. Seven samples will be taken at intervals of 6 hr., 24 hr., one wk., two wk., three wk., and four wk. Serum glucose, liver glycogen, and total serum amino acids will be determined to relate to estimations of total body lipid, total body nitrogen, and pesticide residues.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0289, PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS

P.M. MEHRLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Parameters of nitrogen metabolism will be studied on fish receiving various doses of selected pesticides. Chronic and acute exposures of pesticides will be given by feeding and bath. Blood serum and liver preparations will be analyzed for specific amino acids, total protein, and collateral constituents related to lipid and carbohydrate metabolism. Biological activities of oxidative diaminases and amino tranferases are studied to elucidate mechanisms of induced dysfunction of intermediary nitrogen metabolism by selected pesticides. Chemical assays for amino acids will be carried out by GLC.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0290, PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS

P.M. MEHRLE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Parameters of nitrogen metabolism will be studied on fish receiving various doses of selected pesticides. Chronic and acute exposures of pesticides will be given by feeding and bath. Blood serum and liver preparations will be analyzed for specific amino acids, total protein, and collateral constituents related to lipid and carbohydrate metabolism. Biological activies of oxidative diaminases and amino transferases are studied to elucidate mechanisms of induced dysfunctions of intermediary nitrogen metabolism by selected pesticides.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0291, PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS

D.S. MINTZ, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Pilot studies of intact and isolated nerve preparations are to be carried out using the Beckman Dynagraph II, oscilloscope, and photographic recording equipment. Thresholds, action potentials, accommodation, inhibition, refractory periods, and other associated neurological phenomena will be studied. Changes of normal characteristics induced by neurological toxicants will be evaluated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0292, MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH

E.T. OBORN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

For acute concentrations of malathion - Sexed bluegills would be exposed to acute or near acute concentrations of malathion in either/or both bath water or from capsule ingestion. Sample harvest would follow 24 hours later.

For chronic concentrations of malathion - Sexed bluegills would be exposed to chronic concentrations of malathion for 30 days in either bath water and/or in the feed. Sample harvest would follow the 30-day exposure.

After both acute and chronic exposures to malathion, brain and blood would be incubated and measured for acetylcholine hydrolysis. Additional procedures followed and methods used would be in accordance with standard colorimetric analysis. Blood smears would be taken and blood coagulation time and hematocrit percent would be measured. After dissecting and proper processing, the tissues would be examined for iron, manganese, copper, zinc, phosphorus, calcium, and magnesium content.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0293, UPTAKE AND METABOLISM BY FISH OF 2,4-D DIMETHYL AMINE SALT

C.A. RODGERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Rainbow trout, channel catfish, bluegills, and bass will be exposed to 1.0 and 5.0 ppm of the Dimethyl Amine Salt of 2,4 Dichlorophenoxyacetic acid under laboratory conditions. 14C ring labeled 2,4-D will be used as a tracer to determine total residue levels and distribution in organs. Exposure will be for three weeks with variable sampling intervals. Tissue extracts with high residue levels will be examined by TLC.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0294, CONTINUOUS-FLOW BIOASSAY OF PESTICIDES TO EVALUATE THE ACUTE AND CHRONIC EFFECTS OF PESTICIDES TO FRESHWATER INVERTEBRATES

H.O. SANDERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The proposed research will evaluate the acute and chronic effects of pesticides and combinations of pesticides on aquatic invertebrates exposed in continuous-flow systems. We will derive estimates of TL-50's for various periods of exposure under standard conditions of temperature and water quality. Particular emphasis is to be placed on sensitivity of different life cycle stages, molting, and emergence success.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0295, DEVELOPMENT OF TECHNIQUES FOR IDENTIFICATION OF PESTICIDES AND THEIR METABOLITES BY MASS SPECTROMETRY

D.L. STALLING, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

A Perkin Elmer Model 270 mass spectrometer-gas chromatograph will be installed and employed to identify pesticides and their metabolites and other compounds of interest in fish, water, and related samples. Carbon-14 labeled insecticides will be employed to aid in the separation and purification of pesticides prior to mass spectrometric examination. The study of metastable ions by defocusing normal ions will be employed and should greatly assist structure identification.

The initial efforts will be directed toward developing techniques and optimizing operating parameters as well as obtaining standard spectra of pesticides and metabolites. The use of the direct probe for introducing samples chromatographed by thin layer chromatography (introducing the sample while still on the adsorbent) will be studied. The use of capillary columns for separation of compounds by GC will also be evaluated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0296, METHOXYCHLOR-CAUSED EFFECTS ON CUTTHROAT TROUT PHYSIOLOGY - CHRONIC TOXICITY OF INSECTICIDES TO COLD-WATER FISH

D. SWEDBERG, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The purpose of the work is to measure chronic effects from the exposure of cutthroat trout to methoxychlor at Jackson, Wyoming. Fish will be divided into lots and sub-lots and held in pens in hatchery raceways. Some groups will be given no methoxychlor, some given methoxychlor in feed at two levels, and some given methoxychlor baths at two levels. Samples will be taken according to a pre-arranged schedule, and fish will be examined and measured for growth, pathology, incidence of disease, blood chemistry, insecticide residues, mortality, reproduction, and quality of offspring. Comparisons among lots will be made to assess effects of methoxychlor.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0297, THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA

A.R. GAUFIN, Univ. of Montana, Graduate School, *Missoula, Montana* 59801

Samples of water, mud, plankton, higher aquatic plants, fish, bird eggs, and fat from birds as pheasant, and deer will be analyzed with a gas chromatograph for residual pesticides. The procedures to be used for the chromatographic analysis will necessarily have to be varied with the type of sample, but analyses performed on deer fat samples during the last year are indicative of methods which will be used. The analyses were performed using a model 27-700 chromatograph manufactured by the Jarrell-Ash Co. The chromatograph is equipped with an electron capture detector employing tritium coated foil as an electron source. The 46' x 1/4' pyrex column was packed with 1.5% Se- 30 on Chromasorb G SMCS, A/W, 70/80 mesh. The carrier gas, nitrogen, was maintained at 28 lbs. per sq. inch. The column temperature was 185 degrees C.; the detector temperature was 190 degrees C.; the injector temperature was 185 degrees C.

The extraction procedure was the same for each sample. Fifteen grams of the wet tissue were dessicated for 36 hours at 60 degrees C., then transferred to a mortar and pestle and homogenized. A 1.10 gram sample of the homogenized material was extracted in a 10 milliliter tissue grinder four times, using 5 milliliters of nano grade hexane for each extraction. The 20 milliliters of extract were filtered, the filtrate evaporated to 5 milliliters and transferred to a tightly capped serum vial for analysis. For the analysis 15 to 30 microliter aliquots were injected into the chromatograph.

The number of samples which will be analyzed will be dependent on the personnel and time available, but enough samples will be tested to be significant. The samples will be taken from various areas in the Flathead Lake-Ninepipe Reservoir drainage system and pesticide levels will be correlated with such data as sources of contamination, plankton productivity, nesting populations of ospreys, fish distribution and kills. Inasmuch as a project is being conducted at the Biological Station dealing with plankton productivity and water quality in the lake, and the Fish and Game Department is conducting a study of fish populations in the lake this proposed project will be coordinated with these other studies.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0298, THE RELATIONSHIP BETWEEN THE USE OF AGRICULTURAL CHLORINATED HYDROCARBONS AND THEIR RESIDUES IN CHANNEL CATFISH

N. STUCKY, State Game & Parks Commission, *Lincoln, Nebraska* 68509

Objectives: 1. To complete and publish the manuscript begun in Segment 15. 2. To complete statistical analysis of data collected from six drainages in Nebraska and prepare for publication those aspects of the study which warrant reporting in technical journals.

Procedures: 1. Complete and publish the manuscript begun in Segment 15. This will be a descriptive paper expressing the results obtained from analyzing channel catfish fat and blood samples for DDT and dieldrin residues. Samples were collected from 18 major drainages in Nebraska. The manuscript will be submitted for publication in 'Pesticides Monitoring Journal.' 2. Compile data obtained from six major drainages and analyze statistically the relationship between pesticide residue detected in fish and various physical parameters. The established parameters are: rainfall, land use, drainage basin size, and calculated amount of pesticides applied during the period from 1960 to 1964. Preparation of a manuscript for publication is conditional pending the outcome of the statistical analyses.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0299, ACCUMULATION OF PESTICIDES IN MENHADEN

S.M. WARLEN, U.S. Dept. of Commerce, Mid Atl. Ctl. Fish. Res. Ctr., *Beaufort, North Carolina* 28516 (028176406)

Technical Objective: Identify and quantify the organochlorine insecticides in successive life history stages of Atlantic menhaden and in the ambient waters and the food of menhaden. Measure uptake and loss rates of selected insecticides, determine uptake sites, and test effect on growth of menhaden.

Approach: Monitor insecticide residues in bi-weekly samples of menhaden, water, plankton-detritus, and sediments of the Newport River, N.C. Measure uptake rates of C14-labelled insecticide metered into the water and in food. Subsequently measure loss rate of the acquired insecticide. Changes in length of fish in experimental and control groups will be the criterion for determining the chronic effect on growth of constant or intermittent exposure to persistent pesticides.

Progress: Have collected ovaries and testes from adult menhaden, also have made collections of larval and juvenile menhaden throughout and 8-month period and water and plankton-detritus for a 2-month period. Pesticide residue analyses of samples by liquid-gas chromatography have begun. Studies on uptake and loss rates and effects on growth have not yet begun.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0300, THE EFFECT OF DIELDRIN ON SURVIVAL AND DEVELOPMENT OF FISH EGGS

R.A. TUBB, Ohio State University, Graduate School, *Columbus, Ohio* 43210

Dieldrin is the most commonly found insecticide in the major river basins of the United States (Breidenbach, 1967). Over 1.5 million acres in Ohio are treated annually with aldrin which is rapidly oxidized to dieldrin. Natural populations of fishes and fish eggs have been surveyed for dieldrin residues. Currently eggs from Stizostedion vitreum, Ictalurus punctatus and Pylodictus olivaris are being subjected to concentrations of 0.05 ppb to 125 ppb dieldrin.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0301, THE UPTAKE OF DIELDRIN IN THE THREE RIDGED NAIAD, AMBLEMA PLICATA

R.A. TUBB, Ohio State University, Graduate School, *Columbus, Ohio* 43210

Amblema plicata occurs throughout the Ohio River drainage and is becoming increasingly important for export in the cultured pearl industry. Since this mollusk remains stationary for long periods of time, it can act as a pesticide monitor in streams. Recent studies have shown that naiads concentrate chlorinated hydrocarbons. This study is an attempt to find the levels of dieldrin in natural populations and experimentally determine the uptake and excretion rates of the pesticide.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0302, TOXICITY OF SELECTED METALS TO CONDITIONED FISH

F.W. WEIR, Ohio State University, School of Medicine, *Columbus, Ohio* 43210

The concentrations of copper, zinc, cadmium, and malathion which impair conditioned responses of fish after short-term exposure will be compared with the concentrations which produce deleterious effects on the life cycle of fish after chronic exposures. Research will begin June, 1970, and is expected to continue through May, 1972.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0303, BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS

D.R. BUHLER, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00921)

OBJECTIVE: Investigate the effects of various microchemical environmental contaminants on the biochemistry and physiology of animals.

APPROACH: Initially we plan to examine the effects of the chlorinated bisphenols especially hexachlorophene, trivalent and hexavalent chromium and the chlorinated hydrocarbon pesticides on selected biochemical and physiological systems. The absorption, fate and metabolism of orally and percutaneously absorbed hexachlorophene in the dog, rat and fish; the histopathology of chlorinated bisphenol intoxication; the binding of bisphenol to macromolecules; and the effects of the chlorinated bisphenols on selected electron transport enzymes will be investigated. The uptake and distribution of trivalent and hexavalent chromium and their effects on various biochemical and physiological systems will be studied using fish as a simple model system. This latter phase of our investigations also will include an examination of energy production, stress tolerance and the adaptation to temperature in fish previously exposed to chromium. The influence of pesticides on free amino acid, trace heavy metal and calcium metabolism will be studied, using rats, birds, and fish.

PROGRESS: Levels of hexachlorophene in sewage treatment plant effluents and in the Willamette River have been measured by gas chromatography and the presence of these chemicals verified by mass spectrometry. Other investigations have shown that hexachlorophene is quite toxic to small trout with a 24 hour TL(m) concentration of less than 100 ppb. Initial studies in rats have shown that administered hexachlorophene is conjugated and excreted by rats primarily in the bile. Hexachlorophene also has been found to be a very potent inhibitor of oxidative phosphorylation in rat liver mitochondria.

SUPPORTED BY Oregon State Government - Salem

1.0304, EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS

R.A. MILLEMANN, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

Studies are continuing on the establishment of a well-balanced community of organisms in laboratory models of an estuary. The chronic effects of Sevin and other pesticides on members of such communities will be studied. Studies are in progress on the effects of the insecticides Sevin and Dursban on the survival, growth, and reproduction of the Dungeness crab, the viviparous shiner perch, and the oviparous chum salmon. Biochemical studies on the modes of action of Sevin and its metabolites on estuarine organisms are continuing.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - C.P.E.H.

1.0305, EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS

R.E. MILLEMANN, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00665)

OBJECTIVE: Evaluate the acute toxicity of sevin to certain estuarine organisms.

APPROACH: Use short term bioassays. Determine the effects of sevin on a community of organisms in artificial mud flats. Follow the residual life and metabolism of sevin in estuarine organisms and in their environment. Study compounds related to sevin, as well as other pesticides.

PROGRESS: Studies on factors necessary to maintain animal communities in laboratory models on an estuary were completed. The effect of the insecticide sevin on such communities will now be studied. Studies on the effects of sevin on survival and growth of the Dungeness Crab were completed. A manuscript reporting the results has been accepted for publication by the Journal of The Fisheries Research Board of Canada. Studies on the effects of sublethal concentrations of the insecticide dursban on reproduction and growth of shiner perch are being continued.

SUPPORTED BY Oregon State Government - Salem

1.0306, PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES

A. KURTZ, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01804)

OBJECTIVE: Determine pesticide residues on plants and animals. Develop standardized sampling and analytical methods for pesticide residues. Distribution and coordination of pesticide residue information.

APPROACH: Determine residues on fruit, vegetable, forage and animal products. Chemical and biological methods of residue analysis will be used. Emphasis will be on developing methods for new chemical analyses, determining pesticide residue on untested crops, and improvement of methods not now entirely satisfactory. Research data from all NE stations will be coordinated, residue disappearance curves on all types of crops will be prepared, and other pesticide information of value to this and other regions will be distributed.

PROGRESS: A micro florisil cleanup method as described by Henry F. Enos, et al., Perrine Primate Research Branch, USPHS, Perrine, Fla., was instituted. The method involves the grinding of 500 mg samples in Dual tissue grinders, handling of small liquid volumes with disposable Pasteur pipettes, and the use of only 1.5 g florisil for the cleanup stage. A large number of animal parts and organs have been analyzed with these procedures. The technique is now being used to analyze all fat samples from cattle adipose tissue, milk butterfat, and fish oils. Apple pomace has been found to be an effective and safe cattle feed in Pennsylvania in using current processing methods and at current DDT contamination levels. Fat samples contained no more than 3 ppm total DDT when fed pomace for six months. Lake Erie Coho salmon, caught near the Pennsylvania shoreline, were found to contain DDT within the legally prescribed limits. Maximum concentration was found to be 1.2 ppm based on whole fish filet. A collaborative butterfat analysis study for BHC was completed under the auspices of the FDA District Laboratory in Buffalo. Methods generally were found to be good and in needed areas corrective procedures are being instituted. The Pennsylvania Station is cooperating with other Pennsylvania Laboratories and the Buffalo FDA Laboratory in monitoring and attempting to solve a serious BHC milk contamination problem. Cows high in BHC are being given special rations in an effort to reduce the contamination.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0307, PESTICIDE TOXICITY TO MARINE FISH AND INVERTEBRATES

UNKNOWN, U.S. Environ. Protection Agcy., Narragansett Laboratory, *West Kingston, Rhode Island* 02892

No summary has been provided to the Science Information Exchange.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0308, EFFECTS OF TOXICANTS UPON FISH MOVEMENT PATTERNS

J. CAIRNS, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (VA-0303229-1)

OBJECTIVE: One of the most critical needs for industrial pollution control is a biological monitoring technique that can be associated with the effluent system and provide continual information feedback on quality. Most biological assessment techniques either estimate how much waste can be tolerated on the basis of bioassays or how much damage, if any, has occurred after the waste has been placed in the stream. These are worthwhile assessments but they do not provide rapid and continual information on waste quality. The objective is to develop a rapid means of assessing the non-lethal effects of toxicants upon fishes.

APPROACH: Goldfish and several other test species will be exposed to zinc and several other test compounds to assess the response range to a specially designed apparatus that measures fish movement. Also, a species, such as Aequidens portalegrensis, will be placed in several 'no response' or 'safe' concentrations to breed, and the growth and reproductive success will be determined.

SUPPORTED BY Virginia State Government

1.0309, INHIBITORY EFFECT OF DDT IN ATPASE ASSAY MIXTURES

C.B. CROSTON, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Cook, Washington*

Homogenates will be made of fish tissues, particularly liver and muscle, and will be assayed for adenosine triphosphatase activity. Various amounts of DDT will be added to the assay mixtures to measure the inhibitory effect. A few percentages of liquids having a wide range of solvent powers, such as dimethylformamide and dimethylsulfoxide, will be included in the assay mixtures to attempt increased dissolution of the DDT. The amounts of inhibition will be compared to distinquish different ATPases of cellular fractions, tissues and fish species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0310, EFFECT OF PESTICIDE RESIDUES ON GAME FISH POPULATIONS

W.D. BRUNSON, State Dept. of Game, *Olympia, Washington* 98501

Project: To determine the effect of pesticides on game fish populations.

Objective: To determine the timing in respect to life cycle and the method by which pesticides accumulate in immature fish and the physical changes which result from this accumulation.

Procedures: Monitoring will be accompanied by microscopic examination.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0311, ELIMINATE OR REDUCE EFFECTS OF PESTICIDE RESIDUES

W.D. BRUNSON, State Dept. of Game, *Olympia, Washington* 98501

Project: To eliminate or reduce effects of pesticide residues on game fish.

Objective: To eliminate or reduce the effects of pesticide residues on game fish in trout hatcheries.

Procedure: Activated carbon filter will be installed and special pesticide free diets (if available) will be fed selected lots of fry to determine if mortalities can be reduced by this method. Filters will be experimented with at the Game Department's Columbia Basin Hatchery which has a record of mortalities indicating that the major cause may be the presence of DDT and its metabolites. Dietary experiments will also be conducted at the Basin Hatchery.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0312, EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - ORGANOCHLORINE PESTICIDES AND DISEASE RESISTANCE MECHANISMS OF RAINBOW TROUT

G. WEDEMEYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle, Washington* 98115

Inhibition of Na ion, K ion-activated adenosinetri phosphatase (salt pump) of kidney, brain and gills is potentially important in the susceptibility to stress, and hence infection, which has been noted in fishes chronically exposed to organochlorine pesticides.

The hypothesis will be investigated using chlordane, DDT, and endosulfan with the rainbow trout as the test species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0313, SUBLETHAL AMOUNTS OF ORGANIC INSECTICIDES AND FISH

M. KATZ, Univ. of Washington, School of Fisheries, *Seattle, Washington* 98105

Because of the rapid progress of knowledge being accumulated during the past year, the study is being modified significantly from the original application. There will be two major portions of the study. 1. The principal investigator and assistants plan to measure and identify the chlorinated hydrocarbons being accumulated by trout in the commercial, state and federal trout hatcheries in Eastern Washington. After these parameters are established, the egg-bearing females will be transported to a commercial hatchery in the vicinity of Seattle, and the loss of chlorinated hydrocarbons will be followed in the adult fish and the eggs that are derived from these fish.

This is an effort to determine the rate of excretion or breakdown of chlorinated hydrocarbons that is occurring under the hatchery operating conditions. These data obtained will document the solution to an insecticide toxicity problem that has been solved empirically by the commerical trout grower. The state and federal hatcheries who have not been able to follow this procedure are suffering disastrous egg losses. The loss of the chlorinated hydrocarbons will be evaluated by chemical analysis of the tissues of the adult fish and of the developing eggs.

2. A second project is to investigate the possible use of activated charcoal in fish feeds to reduce the absorption of chlorinated hydrocarbons which are almost universally present in the prepared fish foods fed to trout. Artificial diets will be made up containing 0.1, 1.0 and 5.0 ppm of DDT and other diets will be made up of the same concentrations of DDT but containing 0.1%, 1% and 5% activated charcoal. These diets will be fed to fish and their growth mortality and reproductive success will be measured. If preliminary trials are successful, appropriate analyses for DDT will be made.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

1.0314, RESIDUES OF THANITE IN FISH MUSCLE

J.L. ALLEN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Thanite (isobornyl thiocyanoacetate) is a promising fish collecting aid, but to comply with U.S. Food and Drug Administration requirements, information on residues in fish is required. After a suitable analytical method is obtained (work unit FR-2125-1156-70-6) selected fish will be exposed and analyzed for Thanite residues at selected withdrawal intervals. Observations will be made on the length of time necessary for the disappearance of residues.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0315, RESIDUES OF TFM IN FISH--LA CROSSE

J.L. ALLEN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

TFM (3-trifluoromethyl-4-nitrophenol) is an effective agent for control of sea lamprey. The registration of this control agent is partially dependent on the concentration and persistance of TFM residues in fish.

Selected fish are exposed to concentrations of TFM which are effective for control of sea lamprey. The fish are than placed in fresh water. Samples of fish are taken at selected intervals and analyzed for TFM residues by gas chromatography. This information indicates the amount of TFM residue taken in by the fish and the length of time required for elimination of the TFM residue.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0316, STATIC BIOASSAY OF TRACERS AND DYES AGAINST FISH AND INVERTEBRATES

L.L. MARKING, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Organic dyes are used by fishery managers and fish culturists to: 1. trace movements and velocities of surface and underground waters. 2. tag applications of toxicants or herbicides in aquatic environment. 3. 'tattoo' or mark fish subcutaneously for future identification. 4. arrest infections by fungi on fish and fish eggs.

A primary step in the clearance and registration of a dye is a thorough evaluation of its toxicity (safety) to fish. Candidate tracers and dyes are found in the literature or referred to us by fish culturists or fishery biologists. Standard bioassay methods are used to establish lethal and nonlethal concentration for selected species of fish. Lethal concentrations (LC50's) are derived for selected life stages of fish in waters of different temperature, water hardness, and pH. Additional bioassays may demonstrate the persistence of the chemicals in water and the effects on other organisms within the environment. The results indicate whether the candidate control warrants further development as a tool for fishery management.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0317, FISHERY RESOURCES PROGRAM

R.A. RAGOTZKIE, Univ. of Wisconsin, School of Letters, *Madison, Wisconsin* 53706

The program is divided into four major areas: I. Biological consequences of introducing exotic fishes into the Great Lakes. A. Coho salmon (2 projects). B. Alewife (3 projects): II. The effects of biocides on the fauna of the Great Lakes: A. A pathology study (1 project): B. Pesticide levels of wintering birds (1 project): III. Bacteria in Great Lakes fishes: Intestinal, disease and pollutional relations. (1 project): IV. Utilization of trash fish: A. Fermentation of fish lipids 'in situ.' (1 project): B. Biohydrogenation of fish oil fatty acids. (1 project).

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0318, CHRONIC TOXICITY OF PESTICIDES TO COLD-WATER FISH

D.V. SWEDBURG, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Jackson, Wyoming*

Aroclor 1248 will be administered for 160 days to immature lake trout in dietary concentrations of 1,2, 3,6, and 12.0 mg/kg of food giving dosage rates of 36.9, 108, and 360 ug/kg of body weight per day. Aroclor residues, mortality, and pathology will be evaluated throughout treatment and for 70 days after treatment. The fish will be tested for thyroid activity, recovery time from hexabarbital anesthesia, and their ability to withstand thermal shock after the exposure.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0319, EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT

H.H. FUNDERBURK, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA-05-0003)

OBJECTIVE: Study absorption, translocation, and distribution of a phloem mobile herbicide (2,4-D) and a xylem mobile herbicide (simazine) in Eurasian milfoil. Study the effect of diquat, paraquat, simazine, dichlobenil, and at least 1 additional promising aquatic herbicide on certain metabolic processes of aquatic plants. Study the degradation of diquat, simazine, and 2,4-D in an aquatic environment (water, plants, soil and fish). Determine the effect of promising aquatic herbicides on fish.

APPROACH: Labeled and non-labeled compounds will be used in laboratory, growth chamber and field experiments. Analysis will use several chromatography methods, qualitative and quantitive chemical analysis, autoradiography and spectroscopy.

PROGRESS: Degradation of 2,4-DBEE was rapid usually within 24 hours to 2,4-D in all systems containing living organisms. The main degradation products were CO(2) and a complex of 2,4-D and an unknown molecule. Degradation was greatest in carboxyl carbon label and least in ring labeled 2,4-D. Absorption and translocation by watermilfoil was greatest with the ester apparently aiding in absorption to structure of the side chain. All plants contained only 2,4-D which was readily translocated acropetally and basipetally as well as leaked out of the nontreated root and shoot. Degradation by UV light may be a factor in degradation of the ester, with 50% degradation in 12 hours to 2,4-D. Degradation of 2,4-D under the conditions of the experiment was not a large amount. The ester apparently hydrolyzed in water solution since 2,4-DBEE steadily broke down to 2,4-D under such conditions. The effect of 2,4-DBEE on watermilfoil was readily observable, since only 0.029 ppm killed within 14 days indicating the small amount needed for such results.

SUPPORTED BY Alabama State Government

1.0320, REPRODUCTIVE PERFORMANCE OF FISH-EATING BIRDS IN NORTHERN CALIFORNIA

J.R. KOPLIN, Humboldt State College, School of Natural Resources, *Arcata, California* 95521

Objectives: to relate reproductive performance of fish-eating birds in Lassen, Plumas, Humboldt and Del Norte Counties, California to pesticide pollution and to recreational disturbance.

Reproductive performance measured by recording numbers of eggs laid, numbers of eggs hatched and numbers of young fledged by breeding pairs of ospreys, western grebes, eared grebes, pied-billed grebes, double-crested cormorants, great blue herons, Forrester's terns and black terns. Extent and levels of pesticide pollution determined by gas chromatographic analysis of addled eggs and fish. Recreational disturbance measured by comparing reproductive performance of the birds in areas with moderate to heavy recreational activity vs. areas with little or no recreational activity.

Osprey reproduction in Lassen and Plumas Counties less then 1.2 young per breeding pair, the rate considered necessary to maintain population stability. Measurements on ospreys in Humboldt and Del Norte counties, and measurements on reproductive performance of other birds initiated spring 1971.

SUPPORTED BY California State Government - Sacramento

1.0321, CLASSIFICATION, BIONOMICS, ECOLOGY CONTROL OF FOREST INSECTS (OTHER THAN SCOLYTIDAE) IN CAL.

R.W. STARK, Univ. of California, Agricultural Experiment Sta., *Berkeley, California* 94720 (CA-B0-ENT-1777)

OBJECTIVE: Study biology, distribution and factors affecting the abundance of species of sawflies, seed and cone insects, tip weevils and tip moths in California and to seek methods of control.

APPROACH: Surveys of cone and seed insects and their natural control agents will continue. Studies nearing termination include the biology and ecology of a cone beetle, two species of sawflies, a tip weevil, and a tip moth. Future studies involve investigation of control methods for sawflies and methods of sampling and assessing damage of two species of cone beetle. Radiographic inspection of forest tree seed from the California Division of Forestry seed nursery at Davis will continue.

PROGRESS: The use of artificial nesting boxes to augment bird populations, well known in Europe, is relatively new to this continent. Studies now in their third year have demonstrated the applicability of this technique, notably for the mountain chickadee. These studies have been concentrated in stands periodically defoliated by the Douglas fir tussock moth. Results of studies on a complex of scale insects occurring in outbreak numbers suggest that the outbreak was the result of extensive mosquito abatement treatment.

SUPPORTED BY California State Government - Sacramento

1.0322, THE CHEMISTRY AND TOXICOLOGY OF AGRICULTURAL CHEMICALS

W.W. KILGORE, Univ. of California, School of Agriculture, *Davis, California* 95616

This is a program project concerned with the chemistry and toxicology of selected agricultural chemicals. The program is broad in scope, encompassing not only a number of specific research projects, but also a program planning and coordination activity. The activities of the Director's Office involve the planning, activation and coordination of research and training projects related to the mission of the Food Protection and Toxicology Center.

All research projects relate to the Chemistry and Toxicology of Agricultural Chemicals. They are categorized under three general headings: 1) Analytical Methods and Instrumentation, 2) Biological Manifestations of Toxicity, and 3) Environmental Fate of Pesticides and their Effects.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

1.0323, INVESTIGATION OF MEANS FOR CONTROLLED SELF-DESTRUCTION OF PESTICIDES

K.H. SWEENY, Aerojet General Corporation, *El Monte, California* 91734 (14-12-596)

Description: Original contract was to investigate the feasibility of controlled degradation of pesticides. New, unpublished information obtained since the original contract was met indicates that more extensive degradation than to DDE is necessary if severe reproductive effects to predators and fish eating birds is to be prevented. The new requirement for more extensive degradation will require the development of more vigorous catalytic conditions and the use of analytical techniques capable of identifying and determining a variety of products. The increased technical complexity of the work will require the use of more experienced and expensive personnel.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0324, PESTICIDES AND WILDLIFE

M.S. MULLA, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2131)

OBJECTIVE: Study the relationship of insecticides to wildlife species. Develop specific public health insect control measures in wildlife habitats, with the hope to eliminate or diminish hazards to non- target species.

APPROACH: The productivity, food chain relationships and biological characteristics of predominant components of the ecosystem will be investigated. Degradation and detoxification avenues and mechanisms in a variety of habitats and organisms will be elucidated. Residues of insecticides in water, surface and sub-soil strata, aquatic vegetation and non-target organisms, by means of gas chromatography. Colorimetric procedures and other appropriate analytical methods will be studied. The biological and toxicological effects of insecticidal treatments influencing animal populations in the treated area will be investigated will be investigated.

PROGRESS: Residue analytical methods were developed and applied in a field project for Dursban that could accumulate in mud, water, aquatic plants, aquatic organisms, fish, ducks, and insects. Analytical methods were developed for reproductively determining. The true and apparent solubilities of organochlorine pesticides in very pure water and in 'soil water.' The utility of the forced volatilization technique for the cleanup of pesticide or residue-containing extractives was precisely evaluated for several organochlorine insecticides. Biological effects of Dursban an organophosphate larvicide was studied in a freshwater ecosystem. This material was highly toxic to Cladocera, less toxic to Copepods, but not toxic to rotifers.

SUPPORTED BY California State Government - Sacramento

1.0325, SELECTED PESTICIDES VS. WILDLIFE IN AQUATIC ENVIRONMENTS

J.O. KETH, U.S. Dept. of the Interior, Bureau of Sport Fish. & Wlife., *Denver, Colorado*

Objectives: Marshes and other aquatic habitats are treated with insecticides for mosquito control and also exposed to pollution in waste agricultural water. It is necessary to determine the persistence, accumulation, and flow of pesticides through the tropic levels of marsh ecosystems and to learn the effects these pollutants have on aquatic wildlife species. Of special importance is to evaluate the impact on reproduction of predacious birds, many of which, such as the osprey, brown pelican, and white-faced ibis, have suffered reproductive failures.

Procedures: The movements, feeding, behavior and reproduction of marsh birds are studied by observation, capture and marking, collection and analysis of specimens, and a variety of other field and laboratory techniques. Invertebrate food items are collected and analyzed for pesticide content. Nests are examined for egg breakage and samples collected for shell measurement and residue analysis. Various environmental parameters, such as vegetation and water quality are measured.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0326, ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM)

R. UKELES, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Milford, Connecticut* 06460

Recent interest in aquaculture as a means of increasing the worlds food supply and saving commercially valuable species from extinction, has focused attention on the role of unicellular algae in the aquatic environment. The methods of shellfish culture being developed for commercial hatcheries make it necessary to devise means of raising food organisms, namely unicellular algae. We are providing large amounts of unialgal cultures for a pilot plant hatchery and also working on more efficient methods of culture, harvesting and storing algal cells. We have investigated the effects of pollutants found in the environment, as pesticides, herbicides and detergents, on algal growth. The nutritional requirements and effects of antimetabolites on growth of various species are under study, as well as physical factors important in growth, such as pH, temperature, and light.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0327, ECOLOGICAL STUDIES OF WILDLIFE MANAGEMENT PRACTICES

E.P. CATTS, Univ. of Delaware, Agricultural Experiment Sta., *Newark, Delaware* 19711 (DEL00729-E)

OBJECTIVE: Study mosquito prevalence and mosquito-fish predation food chains on low-level impounded salt marshes in Delaware.

APPROACH: Fish in low-level impoundments will be tagged and released to study their movements and concentrations with respect to tidal inundations and mosquito control effectiveness. Stomach analysis of fish will be made and observations of numbers and kinds of conspicuous fish predators recorded. Physical changes such as tides, water temperature, salinity and water table of adjacent upland areas will be measured and their influence on mosquito-fish food chains and marsh ecology evaluated.

PROGRESS: Tabanidae: Canopy traps were refined by enlarging the dimensions and replacing the white muslin apron with one of black polyethylene. The effectiveness of canopy traps baited with dry ice, propane flame, lactic acid, sticky panels and of unbaited traps was compared. Dry ice still proved to be the most attractive bait with high counts of 1000 tabanids per hour. Unbaited traps attracted about 300 flies per hour. Removal of tabanids captured in canopy traps indicates a corresponding decrease in fly population levels suggesting the use of canopy traps for effective local fly control.

SUPPORTED BY Delaware State Government

1.0328, PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS

B.J. LELAND, State Dept. of Pub. Health, *Springfield, Illinois* 62706

Description: The objective is to determine whether substantial amounts of the persistent chlorinated hydrocarbon insecticides are reaching Lake Michigan from Illinois by way of stream discharge, effluent discharge, or stormwater runoff. A second objective of the monitoring program is to evaluate present levels of these insecticide residues found in sediments and within organisms representing different levels of the aquatic food-chain in Lake Michigan and Illinois tributaries. These evaluations will serve as base-line data against which future evaluations can be compared.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0329, FATE OF AQUATIC HERBICIDES IN THE AQUATIC ENVIRONMENT

R.C. HILTIBRAN, State Natural History Survey, *Urbana, Illinois* 61801

The proposed research will investigate the fate of the aquatic herbicides, diquat and endothall, after their introduction in the aquatic environment for the control of specific plant pests.

The toxicity of aquatic herbicides to aquatic plants and fishes has been documented. It has been recognized that aquatic herbicides may adversely affect other aquatic biota, but this has not been as well documented.

Data concerning the persistence of aquatic herbicides in water and their removal from water is accumulating. The research proposed is directed to the point: can aquatic herbicides be used in potable water, where their use may be necessary, and not constitute a potential hazard to people using the water? If so, what herbicides can be used and under what conditions?

The length of time the herbicides can be detected in water will be estimated. How are the herbicides removed from the water? Are the herbicides taken up by the fishes and aquatic biota, and to what extent? What are the interactions of the herbicides with the aquatic environment? Can the aquatic herbicides gain access to food utilized by humans? Data from the proposed research will permit a greater understanding of the questions raised.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0330, THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT

W.H. LUCKMANN, State Natural History Survey, *Urbana, Illinois* 61801

Objectives: 1. To conduct laboratory and field investigations with furadan and select insecticides and herbicides, and to analyze the long and short-term subtle, direct, and interaction responses on the living and non-living constituents of the aquatic environment; (2) to develop and improve analytical and biological techniques and methodology essential to investigations on the fate and effect of pesticides in the aquatic environment.

Approach: Radiolabeled furadan, analogs of furadan, and select other pesticides will be traced through highly reproducible laboratory aquatic food chains containing various combinations of algae, daphnia, snails, tilapia, gambusia, mosquito larvae, and small bluegills. The fate of the pesticide or the effect of the pesticide on organisms within the laboratory aquatic system will be determined.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0331, CONSTRUCTION OF PESTICIDES DEGRADABLE BY NORMAL MICROFLORA OF NATURAL WATERS AND SOILS

R.E. KALLIO, Univ. of Illinois, School of Life Sciences, *Urbana, Illinois* 61801

It is proposed to establish the amount of substitution, halogen or other substituent group, which can be appended to aromatic rings and still leave them degradable by normal microflora in natural waters and soils. An analysis of the kinds of microorganisms capable of degrading such substituted aromatic rings will be undertaken and it will be established whether the enzymes required for the degradation are inducible. Such induced enzyme systems will be studied to see whether their range of aromatic ring cleavage potentials are greater than simply rupturing the ring of the inducer substrate. These data will be correlated with the ground rules required for pesticide (insect or plant) toxicities. Synthesis of molecules containing an inducer, as well as a pesticide active moiety, will be undertaken and tested in the enzyme system.

SUPPORTED BY University of Illinois

1.0332, ILLINOIS LAWS AFFECTING AGRICULTURE

N.G. KRAUSZ, Univ. of Illinois, Agricultural Experiment Sta., *Urbana, Illinois* 61801 (ILLU-05-0163)

OBJECTIVE: Study objectively and supplement with research into the laws of other states, the laws of Illinois of primary importance to farm people; keep teaching materials current and complete; have information for farmers, farm organizations and special interest groups about laws and legislation important to them and about which they request information; and be able to recommend legislation that will improve laws on agriculture.

APPROACH: Study laws of Illinois and other states concerning farm people. Extensive search into reports and digests for cases involving Veterinary Medicine and eminent domain cases. Preparation and presentation of 'Law on the Farm' articles from above research.

PROGRESS: Legislative emphasis in 1968 was on environmental quality and disease control as evidenced by laws strengthening pesticide controls, upgrading brucellosis testing, prohibiting garbage feeding, increasing inspections of poultry and meat processing operations, extending research appropriations for studying the harmful effects of agricultural chemicals on fish and wildlife, etc. These laws are constantly studied for their impact on agriculture and for inclusion in the some 30 printed publications from Agricultural Law that must be maintained currently. During the year Circulars on Drainage, Condemnation and Taxes were substantially revised and republished. Presently, research on new legislation and on court decisions will be used to revise or rewrite ten additional publications. Estimates indicate that the annual disappearance of Agricultural Law publications is near 75,000. This is an increase of 20,000 from the College Editor's report made two years ago. These publications are having a particularly significant influence on farm business organization and estate planning by farmers. For example in a recent case study of 25 farm corporations, over half volunteered the information that they and their attorneys used our publications as a basis for decision. Other legal subjects demanding research time during the year included the Uniform Commercial Code, Water Pollution Law, Land Titles, and Intergovernmental Relationships.

SUPPORTED BY Illinois State Government - Springfield

1.0333, DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM

R.L. METCALF, Univ. of Illinois, School of Arts, *Urbana, Illinois* 61801

Little is known about the environmental fate, biodegradability, and ecological magnification of the thousands of organic micropollutants entering the environment as industrial wastes, pesticides, detergents, etc. A simple model ecosystem with a seven element food chain is used to evaluate these properties for micropollutants of any type by introducing a radiotracer preparation of the compound into the ecosystem, allowing it to cycle into the food chains, and assaying the magnitude and nature of the radiolabeled products by thin layer chromotography, radioautography, scintillation counting, etc. As a result of the total appraisal each micropollutant can be rated for the degree of hazard that it poses as an aquatic environmental pollutant. It is proposed that the method may be of value as a standard system for judging the suitability of proposed new pesticides and industrial chemicals for uses that may affect water quality and lead to the establishment of criteria and standards for permissible chemical contamination of raw water supplies. In addition, the method will provide data leading to the preparation of a catalogue of ecosystem biodegradability in which specific types of organic compounds, including ring systems and substituent groups, can be characterized for their relative biodegradability and capacity for ecological magnification.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0334, ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE

T.L. HOPKINS, Kansas State University, Agricultural Experiment Sta., *Manhattan, Kansas* 66502 (KAN00781)

OBJECTIVE: Devise and improve sampling, extraction, and analytical techniques to facilitate quantitation of pesticide residues and degradation products in soils, plants, and animals. Conduct a regional study of the interaction of organophosphate insecticides and triazine herbicides employed for control of corn pests. Examine the action, persistence, degradation, and translocation of selected biocides and their metabolites in plants, animals, and microorganisms. Describe and evaluate biocide cycling through the soil and water environment, particularly in reference to food chains.

APPROACH: Standardize methodology; modify new and existing techniques. Study absorption and translocation in plants and relation to soil characteristics; interaction of chemicals; determine degradation products and metabolites and persistence in plants in treated soil. Determine biological effects upon total environment; determine role of chemicals on soil microorganisms and soil arthropods. Determine mechanisms of transport in aquatic environment with respect to source, concentration and adsorption by suspended material and relation to plankton and fish; and when feasible, in soil environment, involving predator-prey relationships.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0335, IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS

J.B. DIMOND, Univ. of Maine, Agricultural Experiment Sta., *Orono, Maine* 04473 (ME00202)

OBJECTIVE: Continue studies of the ecological significance of long-lasting DDT residues to contaminated forest animals; monitor the effects on the forest ecosystem of fenitrothion applied for control of the spruce budworm.

APPROACH: As a result of DDT applications for spruce budworm control in several previous years, areas can be found with widely ranging levels of long-lasting DDT contamination in soils and several organisms. Population success of animal species in heavily contaminated areas will be compared to lightly contaminated areas. Special attention will be paid to reproductive effects. Fenitrothion has replaced DDT as the recommended chemical for spruce budworm control. Little is known of the environmental impact of this new chemical. Several phases will be studied including effect on aquatic insect populations, on parasites of the budworm, and the effectiveness of the chemical itself in controlling the target insect.

PROGRESS: Emphasis continued on the determinations of levels of DDT and metabolites remaining in various components of the forest ecosystem up to 10 years following 1 to 3 applications. Monitoring of soils, some plants and many animals is complete for the terrestrial environment. Residue determination in aquatic communities is nearly complete. Residues are seen to persist through 10 years, with some decline, in most animal species and in soils. There is abundant evidence of food chain magnification and of residue build up with successive applications of DDT. A series of 300 brook trout were taken from 50 streams having varying spray histories. The fish can be expected to cover a broad range of residue contamination. We will attempt to correllate differences in growth or anatomical parameters with residue level.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0336, AN INVESTIGATION OF THE EFFECTS OF DDT AND OTHER CHLORINATED HYDROCARBONS ON THE GROWTH OF EURYHALINE MICROALGAE

R.L. VADAS, Univ. of Maine, School of Agriculture, *Orono, Maine* 04473

The proposed research plan involves laboratory studies directed at determining the effects of DDT and other chlorinated hydrocarbons on the growth and photosynthesis of euryhaline microalgae to DDT and other pesticides will be investigated.

The main approaches to these problems are as follows: Growth studies will be conducted in light and temperature controlled growth chambers. Periodic cell counts will be used to determine growth rates at varying pesticide concentrations. Photosynthetic rates will be determined by changes in CO2 concentrations using an infrared gas analyzer. Resistance to pesticides will be determined through long term growth studies at varying pesticide concentrations.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0337, STUDY OF CHRONIC TOXICITY OF LINDANE TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS

K.J. MACEK, Bionomics Inc, *Wareham, Massachusetts* 02571 (68-01-0154)

Description: Conduct a study on the acute and chronic toxicity of parathion to the brook trout, Salvelinus Fontinalis; the bluegill, Lepomis macrochirus; the fathead minnow, Pimephales promelas; Daphnia magna; the scud, Gammarus lacustris; and the midge, Tendipes (Chironomus) plumosos.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0338, MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS

R. REINERT, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Ann Arbor, Michigan* 48107

A laboratory program designed to compare the relative importance which direct uptake of insecticides from water and biological magnification via the food chain have on the buildup of chlorinated hydrocarbon insecticides in aquatic communities.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0339, ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM

R.C. BALL, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00961)

OBJECTIVE: Develop methods of evaluating effects of low levels and chronic input of pesticides in an aquatic habitat. Study of pathways and mechanisms of movement through the aquatic ecosystem, and identification of biotic effects at each trophic level.

APPROACH: The precision, reliability, and specificity of 'stress' analysis technic tested on insecticides in two artificial streams. Criterion will be changes in the mobile fraction of the plasma proteins in fish. Study movement of the toxic materials from the soil into the ponds and follow through the organisms that constitute the food chain leading to game fish.

PROGRESS: The fate of DDT was studied in a productive farm pond and in three artificial pools. The effect of fish and food organisms on the degradation and distribution of DDT was assessed in the pools by placing both trophic levels in one pool, just food organisms in another pool and fish without food organisms in a third pool. DDT applied to the experimental units was lost from the units, apparently by codistillation with evaporating water. DDT in the water was rapidly taken up by the flora, fauna and sediments. DDT deposited on the bottom was degraded to DDD. Both DDD and DDT were recycled back into the water from the bottom. Invertebrates and fish degraded DDT and DDE. Biological transfers of DDT facilitated its degradation to DDE. Increasing the biological productivity of the lentic ecosystem appeared to promote DDT degradation to DDE. The concentration of DDT-R (DDT, DDD and DDE) persisting in the flora and fauna was mediated by the concentration of DDT-R in the water. DDT-R was concentrated from the water about 1 x 10 times by algae, 1 x 10 times by invertebrates and 1 x 10 times by lean fish.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0340, FARM FISH POND MANAGEMENT

R.C. BALL, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00064)

OBJECTIVE: Estimate production of plants and animals per unit area or volume of water in farm type ponds, and natural ponds. Determine extent fertilization of ponds will increase production of fish food (plankton, insects) and fish. Devise practical management programs for farm ponds; this includes the number of fish to plant and harvest. Detect and measure possible detrimental effects of use of fertilizers in fish ponds.

APPROACH: Measurement release of stored nutrients in the subaqueous soils by additon of chelating (EDTA, etc.) materials to the waters. Tracing the paths of nutrients added to the waters through tagging nutrients with radioactive tracers (P), rates of fixation of nutrients and accumulation of organic material (basic productivity) will be measured by the C light-and-dark bottle technic. Input of solar radiation will be measured.

PROGRESS: This project continues to evaluate aspects of water quality as related to productivity and ecology of pond water. Final evaluation of sodium arsenite as an aquatic weed herbicide revealed the impact on the total aquatic system to be severe. Fish food organisms were effectively removed by the herbicide. Results indicate that sodium arsenite should be discontinued as an aquatic weed control agent. Preliminary studies on the ecology of radioactive fallout in lake and pond systems reveals considerable accumulation of Cs by fish over the levels in water; however, these accumulations at present fallout levels are far below hazardous levels for human food items. The prospects of using fallout radionuclides as tools to determine rates of ecological processes such as food conversion and efficiencies are excellent. Dissolved organic acids in farm ponds were isolated in significant quantities. These acids interacted significantly with the alkalinity of natural waters and appear to be a consideration in the process of eutrophy of lakes. The yellow organic acids can be a carbon and energy source for algae but in higher concentrations are toxic to zooplankton, a main fish food item.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0341, EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS

J.W. BUTCHER, Michigan State University, Agricultural Experiment Sta., *East Lansing, Michigan* 48823 (MICL00720)

OBJECTIVE: Assess the effect of insectide applications on selected species of microarthropods which are important in the process of organic decomposition. Examine the effect of insecticides on selected species of microarthropods under laboratory conditions in regard to their biology, development, and ecological displacement. Investigate the effect of insecticides on the interaction between phytophagons insect species and the plants parasite of jack pine, Melampryum lineare.

APPROACH: Monitor Collembola, Acari, and Opiliones species within dieldrin treated and untreated woodlots in Monroe County. Determine changes in abundance and species complex in relation to residue persistance. A series of test plots have been established on South campus study the effects of dieldrin and DDT on the abundance and changes in the species complex of Collembola. Acari, and other soil arthropods. These plots are on cultivated land and will be planted to corn yearly. Collembola and Acari are being cultured under laboratory conditions. Individual species are being used to determine their role in the process of organic decomposition. The consequence of insecticide application on this process is being studied. Studies are underway to determine the effect of feeding of various phytophagous insect species on Melampryum lineare. Field plots have been set up and differences in feeding due to insecticide application are being compiled.

PROGRESS: Information on residue levels in milk, water and soil following treatment for soil insect control has been published or is in press. Current emphasis is on taxonomy and biology of soil Colembola and Oribatid mites and their resistance to chlorinated hydrocarbon insecticides and their role in metabolizing these chemicals to non- insecticidal compounds. A number of manuscripts on these subjects have been published, are in preparation, or in press. The most complete U.S. literature on file on Oribatid mites, along with a reference collection has been compiled at MSU. The Michigan Collembola have been monographed. Laboratory rearing of soil micro and macro arthropods is being carried out successfully and are being used in pesticide food chain and pesticide metabolism studies. It has been established that at least one species of Collembola rapidly degrades DDT to its non-insecticidal metabolite DDE.

SUPPORTED BY Michigan State Government - Lansing

1.0342, BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES

N.R. KEVERN, Michigan State University, Agricultural Experiment Sta., ***East Lansing, Michigan*** 48823 (MICL00940)

OBJECTIVE: Evaluate amount, storage, build-up and releases of pesticides under varying biological and chemical-conditions.

APPROACH: Studies on contamination and levels necessary to produce injury, debility, sterility or mortality will be conducted. The physiological effects of pesticides on energy exchange measured at the cellular level. Direct bioassay and gas chromatography employed to monitor the accumulation of pesticides in aquatic systems. Determine site of damage and identification of effects of detergents, metallic ions, BOD and other chemicals. Rate of transfer, buildup and exchange within the biota of aquatic systmes will be determined.

PROGRESS: The sub-project under this study that has been emphasized this past year dealt with the downstream movement of invertebrate organisms in streams. The nocturnal nature of this movement has been documented in the literature for very small streams. Sampling problems in large streams must be understood before data can have a quantitative meaning. Thus, in order to relate transport of pesticides or other elements via downstream drift, it is necessary to quantify the drift. The purpose of this study was to measure the rate of drift in three contrasting streams and determine what relationship exists between drift rate and degree of enrichment. Additionally an attempt was made to determine how drift is related to current velocity. The three streams chosen for this study were the Jordan River in Antrim County, AuSable River in Crawford County, and Red Cedar River in Ingham County. Two 24-hour series of drift samples were collected in each stream. Samples of benthic invertebrates were collected following each 24-hour drift collecting period. To investigate the relationship of current velocity to drift rate, five series of samples were collected along a transect across the stream at three points where the velocity was different. Although standing crop estimates did not reflect the degree of enrichment in the streams, total drift measurements showed a relationship to enrichment. The relationship between total drift and current velocity was linear, as expected. However, the drift rate of Baetis sp. (may flies) and Simulium sp. (black flies) appeared to be influenced by behavioral as well as physical factors and was therefore non-linear. Methods for sampling drift are discussed with suggestions for standardization of technique.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0343, AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS

V.A. KNUDSON, Michigan State University, Agricultural Experiment Sta., ***East Lansing, Michigan*** 48823 (MICL00959)

OBJECTIVE: Assess the influence of total alkalinity, pH and temperature of the water on the effectiveness of several widely used herbicides. Test the effect of weed control by chemical means on fish- food organisms. Evaluate fertilization as a method of controlling higher aquatic plants.

APPROACH: Preliminary work in the laboratory will include study of influence of water quality on effectiveness of various herbicides. Toxicity of herbicides to fish will be studied in conjunction with the laboratory, experiments. While some fertilization studies can be done in the laboratory, the major effort here will be in farm ponds and small lakes.

PROGRESS: Bioassays were run with two genera of cladocerans, Simocephalus sp. and Ceriodaphnia- sp., an ostracod, and Vivaparus purpurea, a large snail. Herbicides tested included copper sulfate, sodium arsenite, diquat, silvex, 2,4-D, endothal, and Hydrathal-47. The tests generated several conclusions: snails were generally unaffected by all herbicides tested except for copper sulfate, while cladocerans and ostracods were particularly susceptible to H-47, copper sulfate, and sodium arsenite at all levels tested; copper sulfate, even at 0.15 ppm, proved lethal to most organisms tested and should be studied in greater detail, since it apparently is used at toxic levels in the environment. Endothal, silvex, 2,4-D, and, in most cases, diquat, appeared to be relatively harmless to the organisms tested.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0344, TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS

N.C. LEELING, Michigan State University, Agricultural Experiment Sta., ***East Lansing, Michigan*** 48823 (MICL00970)

OBJECTIVE: Processing procedures for the removal, reduction, or detoxification of pesticide residues and conversion products in agricultural commodities. Development of improvement of methods for the determination of pesticide residues in agricultural commodities.

APPROACH: Specific attention is to be directed to the determination of the actual site(s) of origin and magnitude of pesticide contamination in dairy products after they enter marketing channels. Research is planned to attempt to develop standard and more flexible techniques for routine analysis of dairy products.

PROGRESS: Following the preliminary studies of chlorinated hydrocarbon insecticide residue reduction due to cooking which was reported last year, more detailed studies were undertaken. Little difference in magnitude of residue reduction was observed due to cooking method (baking, broiling, frying, deep-fat frying or boiling). Each of these methods reduced the total DDT complex (DDT, DDE and TDE) residue level by about 25%. It was further established that trimming off the belly-flap, lateral line and dorsal fatty regions prior to cooking reduced residue levels between 30% and 40%. Thus, the trimming away of fatty regions coupled with cooking reduces chlorinated hydrocarbon insecticide residue levels in coho salmon to about one-half the level found on a fresh-weight basis.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0345, SELECTED PESTICIDES IN AQUATIC FUNGI IN THE THREE RIVERS AREA

E.S. PENEKE, Michigan State University, School of Natural Sciences, ***East Lansing, Michigan*** 48823

The proposed research plan involves field and laboratory investigations of aquatic fungi from river areas with high incidence of fish infection with Saprolegnia sp. to determine the types of organisms present and the quantities of DDT, TDE, and DDE absorbed in the mycelium. These organisms are eaten by the invertebrates. The main approach in the investigation is to determine the types of aquatic fungi and the accumulation of these selected pesticides in certain aquatics by gas chromatography.

Laboratory investigations would employ the following methods: 1. Isolation of aquatic fungi from the Three Rivers area for testing. 2. Experimentally test the absorption of these pesticides under laboratory conditions. 3. Determine amount of pesticide in the fungi by gas chromatography.

Field investigations would include the determination of pesticide accumulation in aquatic fungi as follows: 1. Colonies of fungi in cages placed in river water would be collected for determination of pesticide accumulation in the mycelium.

Laboratory and field data would be correlated. Significant quantities of pesticides in the aquatic fungi would be of importance in the food source for invertebrates and eventually for fish.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0346, DETERMINATION OF DIGESTION RATES FOR TROUT

G.R. ALEXANDER, State Res. & Dev. Division, *Lansing, Michigan* 48926

Project and Job Objectives: To compare the growth and survival of northern pike living lakes containing various predetermined fish populations.

Procedures: All fish will be removed from two test lakes. One or more species of forage fish, e.g., bluegill, golden shiner, etc., will then be introduced. When a suitable population of forage fish has been established, a known number of northern pike fingerlings will be introduced. Subsequently, pike will be collected periodically by electrofishing, netting, or other suitable means to determine growth rates. Yearly additions of pike fingerlings will be made in the same quantity as the original planting. In one lake the aquatic weeds will be controlled to determine if this measure increases the predation rate. After 3 years the fish populations will be poisoned and final determinations made of pike growth and survival, and size and composition of the food-fish populations. The experiments will then be continued for 3 years, but with the species combinations of pike- bluegill and pike-shiners reversed in the two lakes. The growth of pike in the various water will be compared to determine if pike grow significantly faster on a particular species of fish than on another species.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0347, TOXICITY HAZARD OF POLYCHOLORINATED BIPHENYLS TO AQUATIC LIFE

UNKNOWN, U.S. Environ. Protection Agcy., Duluth Laboratory, *Duluth, Minnesota* 55804

No summary has been provided to the Science Information Exchange.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0348, IN VITRO POTENCY OF SEVERAL ANTICHOLINESTERASE AGENTS WITH SELECTED MEMBERS OF THE AQUATIC ENVIRONMENT

J.W. HOGAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Fish and invertebrates that normally are members of the same aquatic ecosystem exhibit considerable variation in their susceptibility to organophosphate pesticide poisoning. It is possible, therefore, that one or more members of an aquatic ecosystem could be exterminated thru unwise use of a pesticide. Hence, experiments initiated within this work unit will be designed to compare in vitro potency of several anticholinesterase agents. This will be accomplished by exposing brain or nerve tissue homogenates to various pesticides and subsequently determining the magnitude of esterase inhibition which occurs. Common members of a conventional warm water ecosystem will be used as sources of brain or nerve tissue. Pesticides to be tested will be selected on the basis of potential use, mode of action, and availability.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0349, INFLUENCE OF PROTOZOAN ACTIVITY ON HALOGENATED HYDROCARBON RESIDUES - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES

B.T. JOHNSON, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Axenic cultures of a broad spectrum of free living freshwater protozoans will be studied in vitro with selected insecticides.

The parameters of this investigation will be as follows: 1. Effects on protozoan population of the insecticide. 2. Ability of the organism to utilize the pesticide as a sole carbon source. 3. Role of protozoans in degradation of halogenated hydrocarbon pesticides. 4. Study possible use of protozoans as bio-indicators of low concentrations of pesticides.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0350, THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM

B.T. JOHNSON, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Axenic phytoplankton cultures are exposed to different insecticides and herbicides alone and in combination at environmental concentrations. The polychlorinated biphenyl Aroclor series are studied also in conjunction with pesticides.

Effects on photosynthesis are measured by changes in C14-uptake using a liquid scintillation method. Biomass is determined by direct cell count, dry weight and ATP content. ATP is quantitatively determined utilizing the luciferin-luciferase enzyme system.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0351, INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES

B.T. JOHNSON, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Accumulation, retention and passage of polychlorinated pesticides in a freshwater food-chain are studied. Under controlled laboratory conditions experiments are performed with bacteria, algae, protozoa, crustacea, insects and fish using both labeled and non-labeled chlordane, toxaphene and methoxychlor alone and in combination with the non-pesticidal polychlorinated Aroclor series of compounds. Both simple and complex food-chains are developed. Only environmental levels of the pesticides are used. Residue analysis at various trophic levels are made using several chromatography methods, liquid scintillation, autoradiography and mass spectroscopy. Evidence of biological magnification in the concentration of pesticides is explored.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0352, BIODEGRADATION OF PESTICIDES IN A FRESHWATER ECOSYSTEM - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES

B.T. JOHNSON, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Degradation of polychlorinated organic compounds by representative organisms from various levels of an aquatic community are investigated. Under controlled laboratory conditions microorganisms, algae, protozoa, crustacea and insects are exposed to environmental levels of both labeled and non-labeled toxaphene and chlordan. Exposure periods are varied in accordance with the organisms investigated. Degradation products are identified and characterized utilizing thin-layer and gas chromatography, infrared and mass spectroscopy, and autoradiography. Potential degradation pathways are postulated. The influence of non- pesticidal polychlorinated biphenyl compounds (PCBs) alone and in combination with chlorinated pesticides is investigated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0353, POND ECOLOGY AND PRODUCTION AS AFFECTED BY SIMAZINE

F.L. MAYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Five quarter-acre ponds will be stocked with bluegills, 'Lepomis macrochirus', and treated with 0, 0.1, 0.3, 1.0, and 3.0 micrograms of Simazine per liter, respectively. The herbicide will be applied once per year (late March) for two years.

Serial samples will be taken to evaluate the following: fish growth and reproduction, pathology, residue levels (fish, invertebrates, plants, mud, and water), invertebrate population characteristics, plant pigment ratios, pond productivity, and water quality.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0354, STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970

H.O. SANDERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

The objective of this work is to study the role of invertebrate pesticide interaction in the aquatic ecosystem. Pesticide bio- amplification, using aquatic invertebrates in a simple food chain will be investigated. Invertebrate food chains will be established in the laboratory to investigate potential biopassage of labeled insecticides and herbicides from one ecological trophic level to another. Studies will include the following fish-food organisms: scud, glass chrimp, daphnia, fairy shrimp, crayfish, damselflies, mayflies, and mosquito larvae. When available, other organisms will be investigated. The study will also include the effects of continuous exposure of invertebrates to sublethal concentrations of pesticides, which may influence reproduction, life cycle stages, vigor, and resistance of the organisms.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0355, RESPIRATION RATES OF FISH-FOOD INVERTEBRATES EXPOSED TO PESTICIDES

H.O. SANDERS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Columbia, Missouri* 65201

Invertebrates are to be exposed to varying concentrations of several pesticides for short durations. Oxygen uptake and carbon dioxide liberation will be estimated with a Warburg apparatus fitted with macro-vessels. All major pesticide groups such as organochlorines, organophosphates, and carbamates will be investigated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0356, EVALUATION OF GIZZARD SHAD AS A FORAGE FISH

A.D. MING, State Dept. of Conserv., *Jefferson City, Missouri* 65102

Objectives: To evaluate the gizzard shad as a forage fish and to determine its effects on a bass, bluegill, redear sunfish and green sunfish population.

Procedures: Populations of gizzard shad, golden shiners, largemouth bass, redear sunfish, bluegill and green sunfish were stocked in an 8-acre lake at the Big Buffalo Creek Wildlife Area. The population composition, reproduction, fish growth and predator - prey relationships will be followed with frequent seining, meter netting and electro-fishing samplings. Stomach contents of bass and bluegill 4 inches and larger will be collected to determine forage preference and degree of utilization of shad. Spawning success and population structure of gizzard shad will be monitored. If shad become overcrowded, partial treatments with rotenone will be used to selectively thin the shad population. In this case, bass stomachs will be examined to correlate shad availability as forage. Effects on bass growth rates will also be evaluated. Once forage and growth information have been obtained, and providing the shad become established, a harvest schedule comparable to those influencing public use area lakes will be established to determine whether shad will overpopulate under these conditions.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0357, STUDY OF CHRONIC TOXICITY OF PARATHION TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS

A. SPACIE, Union Carbide Corporation, *Tarrytown, New York* 10591 (68-01-0155)

Description: Conduct a study on the acute and chronic toxicity of parathion to the brook trout, Salvelinus Fontinalis; the bluegill, Lepomis macrochirus; the fathead minnow, Pimephales promelas; Daphnia magna; the scud, Gammarus lacustris; and the midge, Tendipes (Chironomus) plumosos.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

1.0358, PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS

R.C. AXTELL, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27607

This project will investigate the threat to estuarine animal life of pesticide residues drained from the state's farm lands by the rivers and streams.

The proposed project will have three main phases: (1) to determine present levels and distribution of pesticides in representative sites in sounds and estuaries along the coast and in streams and lakes of the Coastal Plain; (2) to study experimentally the breakdown or chemical alteration of pesticides in natural waters: and (3) to study the transfer and accumulation of pesticides in food chain organisms, particularly the common and economically important estuarine species.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

1.0359, THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA

J.R. REILLY, Univ. of North Dakota, Graduate School, *Grand Forks, North Dakota* 58201

This information is designed to investigate the importance of the food chain in the initiation and continuance of epornitics of botulism intoxication among waterfowl and to evaluate possible control methods.

Investigations will involve the following: 1. Examination of natural outbreaks of botulism to determine the type involved, the sources of intoxication and the mechanism of transmission, via the food chain. 2. Determination of the mode of entrance of the organism and its toxin into the food chain. 3. The role of invertebrates in the intraspecific transfer to vertebrates. 4. The possible use of marsh inoculation with B. licheniformis as a control measure to reduce or eliminate botulism epornitics.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0360, TOXICOLOGY OF PESTICIDES IN THE ENVIRONMENT

V.H. FREED, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00674)

OBJECTIVE: The approach used in this study is a coordinated, interdisciplinary type of investigation. It involves entomologists, pathologists, pharmacologist, ecologists, analytical chemists, physical chemists, biochemists and mathematicians. The study attempts to assess the current behavior and persistence of pesticides in the environment, the transport across interface between the environment and organisms or uptake, the pharmacodynamics and effects of various levels of organization in the biological system. This will include effects at the molecular level through the whole animal and the effects studied consist both of metabolism by the organism and the effect of the xenobiotic on metabolism and function in the organism. An important feature of the study is the involvement of analytical chemists in all phases of the work. A central analytical facility is available to assist in development of new methods and the quantitation of pesticide and metabolites in the studies.

PROGRESS: Progress has been made in the following areas: Uptake of chemicals from the environment by food chain; analytical chemistry of pesticides including analyses of a number of research standards; metabolism of pesticides by intact organisms as well as isolated systems of enzymes; chemodynamics in the environment; the effect of xenobiotics on metabolism of organisms; effect of xenobiotics on behavioral responses.

SUPPORTED BY Oregon State Government - Salem

1.0361, ENVIRONMENTAL TOXICOLOGY OF PESTICIDES

V.H. FREED, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

The objectives of this proposed program are: 1. To conduct program integrated research on the toxicology of pesticide chemicals and other organic chemicals that may enter man's environment. 2. Investigate the toxicological effects of these chemicals at the several levels of biological organization. 3. To investigate the interaction of other environmental stressors on the toxicological effect of these chemicals. 4. To investigate the chemodynamics of environmental chemicals, particularly with respect to partitioning into exposed organisms across the organism's environment interface.

The research strategy involves identification of areas of lack of knowledge on the toxicology of a given compound, establishment of goals and objectives, and then programming the research to achieve these objectives. The data will be analyzed and synthesized applying kinetic analyses models, as well as other types of data analyses. A common pool of animals will be used in the experiments with an overall treatment or experiment with a primary chemical. Biological, biochemical analytical, and pharmacodynamic data will be obtained on aliquots from this common pool. Where stressors are to be studied these will be imposed as additional experimental variables on the common pool of animals.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

1.0362, PHARMACOLOGICAL AND ECOLOGICAL EFFECTS OF PESTICIDES

C.E. WARREN, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00693)

OBJECTIVE: Developing standards for the use of toxic substances that are adequate to protect the productivity of fresh waters for organisms of value to man. Obtain understanding of how toxic substances influence the various biological functions of the individual organism; and obtain understanding of how toxic substances influence food relations in biological communities.

APPROACH: Pharmacological and bioenergetic approaches will be used in studies of the influences of toxic substances on the biological functions of aquatic organisms; food chains in simplified biological communities will be studied to determine the influence of toxic substances on food relations.

PROGRESS: Recently initiated studies have to do with the influence of pesticides on the population dynamics of fish in ecological systems that provide the fish-food resources. Working with Lyle Clavin of our Statistics Department we hope to develop models of population growth that contain environmental variables including pesticides. Preliminary experiments have demonstrated the population densities of fish which may develop when space is limited, but food is not. Other preliminary experiments have been conducted that show the extent of toxicity from dieldrin imparted to the fish from water, from food and from the two sources combined. This information has provided us with a basis for selecting experimental dieldrin concentrations in the population studies, and the sizes of aquaria to be used. Our previously reported toxicological investigations have included studies at the enzyme, whole animal, and simplified ecological levels. To provide information at the cellular levels the effects of the important industrial toxicant pentachlorophenol on tissue cultures of embryonic cells from Oncorhynchus kisutch have been studied in media containing agamma calf serum. Threshold effects are obtained with 40 mg/l of pentachlorophenol. With 80 mg/l the number of cells is reduced as is the nitrogen, fat, and dried weight of cells developing. However, the individual cells have a larger volume, and contain more nitrogen and have a higher dried weight than control cells.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

1.0363, INTERCEPTION AND DEGRADATION OF PESTICIDES BY AQUATIC ALGAE

L.R. WORTHEN, Univ. of Rhode Island, School of Pharmacy, *Kingston, Rhode Island* 02881

The proposed research involves both collecting blue-green algae from several stations over a two year period and the propagation of axenic cultures of several representative species.

Those collected from natural sources will be examined to determine the extent of pesticide (DDT and dieldrin) accumulation. Radioactive isotopes of the two pesticides will be used to determine if absorption of these compounds takes place, and if these compounds are accumulated in the organism, or more important, if they are degraded and the pesticide metabolites formed.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

1.0364, CHEMICAL BIOCIDES IN LAKES

Y.A. GREICHUS, South Dakota State University, Agricultural Experiment Sta., *Brookings, South Dakota* 57006 (SD00471)

OBJECTIVE: Determine the levels of chemical biocides in the ecosystem of a prairie lake (Lake Poinsett). Study the effects of these chemicals on the ecosystem of this lake.

APPROACH: Plant and animal species of the food chain of the lake fish will be collected at the inlet and outlet areas, the littoral zone, the transition zone and the settling basin zone. The species will be identified and analyzed for pesticides. The fish, also, will be analyzed for pesticides.

PROGRESS: All samples collected for this study have been analyzed and the data are now being processed. Several samples (of both sexes in most cases) of 12 species of fish were examined for 11 insecticides on both a tissue and fat basis. In addition, the water and some components of the food chain have been examined. Some work on fish-eating birds has also been undertaken.

SUPPORTED BY South Dakota State Government - Pierre

1.0365, THE EFFECT OF PESTICIDES ON AN ECOSYSTEM

H.G. APPLEGATE, Texas A & M University System, Agricultural Experiment Sta., *College Station, Texas* 77843 (TEX04001)

OBJECTIVE: At Presidio, Texas, to follow changes in pesticide concentration in soil, water, bird, reptile, and animal tissue, human urine and vegetation for a 3 year period; determine changes in water and soil biota as functions of the physical and chemical environments; compare species and populations of native organisms living in an area heavily treated with pesticides with those from a similar area not treated with pesticides.

APPROACH: Samples of various organisms, soil, water and air will be extracted and studied for pesticides. The pesticide concentrations will be studied in three dimensional space and correlated with time and site of application.

PROGRESS: Previous work indicated that soil temperature, soil alkalinaty and ultra-violet radiation were instrumental in breaking down DDT at Presidio. Laboratory data indicate that of the three factors ultra-violet radiation is the most important and soil alkalinaty the least important. The high incidence of male C. tesselatus has been related to high DDT concentrations. It appears as though DDT biochemically resembles steriod hormones. Methyl parathion appears to be immobile once it reaches the brain of mammals. Preliminary data indicates a linkage between methyl parathion concentrations in the brain and motor behavior.

SUPPORTED BY Texas State Government - Austin

1.0366, STUDY ON THE EFFECTS OF FISH TOXICANTS ANTIMYCIN A AND ROTENONE ON POND COMMUNITIES

R.E. LENNON, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

This is a post-treatment study of the structure of aquatic communities which have been exposed to the toxicants antimycin A and rotenone at concentrations which may be experienced as a result of routine field applications.

The purpose of this study is to identify any alteration in community structure which may result from the addition of the fish toxicants. The specific objectives of the study are 1) to identify any species of algae or invertebrates which may be eliminated following treatment by these chemicals, 2) to measure changes in abundance (suppression) of aquatic organisms which may result from application of the toxicants, 3) to compare effects of treatment with low and high concentrations of toxicants, and 4) to evaluate between the effects of toxicants and of fish grazing on invertebrates.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

1.0367, PESTICIDE LEVELS IN BIRDS WINTERING ON LAKE MICHIGAN

R.S. ELLARSON, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01670)

OBJECTIVE: Investigate pesticide residue levels (particularly DDT and its metabolites) in waterfowl and diving birds wintering on Lake Michigan. Residue levels reflect the degree of contamination of the lake ecosystem. Deleterious effects of this contamination upon the birds will be studied.

APPROACH: Old-squaw ducks and other diving birds accidentally taken in gill nets will be collected from commercial fishermen. Pesticide residues in fat, muscle, whole birds and ingested food will be determined in adult and juvenile birds to determine rates of accumulation, and degree of environmental contamination. Bodily condition of birds will be compared with data gathered in an earlier study of the same avian population.

SUPPORTED BY Wisconsin State Government - Madison

1.0368, INSECTICIDES AND EGG-SHELL DEPOSITION

J.J. HICKEY, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01249)

OBJECTIVE: Evaluate the wildlife side-effects of insecticidal use and to work out the kinetics of DDT transfer through different ecosystems.

APPROACH: The avian effects of DDT in Dutch elm disease control have been evaluated on 7 Wisconsin study areas and the transfer of DDT through soils, earthworms and birds is now being measured. A second project is measuring residues in Lake Michigan sediments, fish, and gulls. A third is evaluating the current status of the peregrine falcon in eastern U.S.

SUPPORTED BY Wisconsin State Government - Madison

DESCRIPTION OF RESEARCH TASKS

2. AQUATIC PEST CONTROL

(Target Oriented Use of Chemical, Biological Cultural, Mechanical Or Physical Control Methods)

2A. AQUATIC INSECTS

2.0001, ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA

K.L. HAYS, Auburn University, Agricultural Experiment Sta., ***Auburn, Alabama*** 36830 (ALA00129)

OBJECTIVE: Determine ecological factors affecting the abundance of deer and horse flies, Tabanidae; cattle grubs, Hypoderma sp ; horn fly, Haematobia irritans (L.). Determine to what extent populations may be regulated by manipulating the environment. Improve and develop traps, baits, and methods of chemical control.

APPROACH: Collect Diptera from animals to determine bloodsucking species abundance. Physical factors of environments of Diptera measured. Specific microenvironments of critical stages of life history measured. Environments will be manipulated in field and laboratory investigations. Principles of environment and food habits fabricated and field-tested. Insecticides applied to stages of life cycle which are not parasitic.

PROGRESS: The 10-year investigation of the species composition of the Alabama tabanid (horse and deer fly) fauna was terminated this year. One hundred and seven species and subspecies are known from the state. An investigation of the oviposition habits of this group of flies showed that egg masses were deposited on plants from the edge of the pond up to 100 feet out in the water with equal frequency. There was a preference shown for different species of plants. Of the plants tested common smartweed (Polygonum hydropiperoides) and rice cutgrass (Leersia oryzoides) were preferred. Thirty-six per cent of the egg masses were parasitized by egg parasites with parasitism ranging from 1 to 70 per cent of the eggs. Only 40 per cent of the parasites were successful in emerging from the eggs. Larvae of the Tabanidae were subjected, in laboratory tests, to predation by other insects in the same habitat. Members of the orders Coleoptera, Odonata, and Hemiptera prey on the newly hatched larvae. Experiments are being conducted to show the rate of cannibalism among these larvae. Dust bags containing malathion, methoxychlor, gardona, tiguvon, and Co-Ral have been placed in covered gates leading to small pens containing a salt trough. Movement of cattle through the gate causes each animal to be dusted with insecticide. All treatments have provided some horn fly control, but the latter three insecticides appear to be most effective. Field research using plastic pools has shown that complete mats of floating vegetation (Spirodela) inhibit mosquito breeding, whereas,

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0002, EMERGENCY INSECT CONTROL MEASURES FOR ALASKA

R.H. WASHBURN, Univ. of Alaska, Agricultural Experiment Sta., ***Palmer, Alaska*** 99645 (ALKP00303)

OBJECTIVE: Devise, emergency control measures for hazardous insect infestations; document outbreaks; recommend control measures against accidental infestations by importation of infested plant materials.

APPROACH: Investigating and documenting reports of unusual insect activity. Corrective measures will be recommended to the Alaska Division of Agriculture.

PROGRESS: Aspen tortrix while slackening slightly in Tanana Valley expanded into Copper River Valley. Sweet corn and vegetable gardens were severely damaged when Aspen exhausted. Red turnip beetle severe on crucifers in Kenny Lake area as well as villages on Yukon. Seed corn maggot injurious to sweet corn under plastic in Palmer area. Oat bird cherry aphid - heavily infested bird cherry throughout areas of State where grown even coating the fruit in Tanana Valley. Carpenter ant weakened a number of buildings built of rough lumber. Household pests prominent this past year have been clover mite, brown banded cockroach, Tribolium, European earwig. Garden springtail was numerous on head lettuce but did no actual damage to the tissue. Alfalfa plots at College station were heavily infected with thrips, only other thrips populaters were in blooms of greenhouse cucumbers. Injury of mites and aphids to raspberries at College was accentuated by very dry summer. Spring mosquito populations were heavy, very troublesome to grazing cattle and man due to very wet, early spring. Total lack of insect problems on peas contributed to success of pea project.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0003, EFFECT OF MOSQUITO CONTROL CHEMICALS ON AQUATIC FAUNA

J.L. LANCASTER, Univ. of Arkansas, Water Resources Research Ctr., *Fayetteville, Arkansas* 72701

It is proposed to make applications of malathion, Abate, Flit MLO and Baytex to all mosquito breeding water each in a square mile section. It is also planned to put ethyl parathion in rice irrigation water in all rice fields wherever they occur in these sections. It is anticipated that two aerial applications of malathion over the entire 4 square miles may be needed each year. Pre and post-treatment samples from each area will be collected, concentrated, and later analyzed in the laboratory to determine what changes, if any, occur in the fauna that can be directly attributed to the chemicals used. Sampling will be continuous on a selected time schedule and comparisons made to similar samples from an adjacent untreated area. The research site (Lonoke, Arkansas) will be divided into four sections to provide for comparison between the four insecticides.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0004, BIOLOGY OF PEST MOSQUITOES, AND CONTROL THROUGH COMMUNITY ACTION

J.L. LANCASTER, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville, Arkansas* 72701 (ARK00713)

OBJECTIVE: Aid in development of mosquito control in Arkansas communities through faunal survey, biological research, and community organization.

APPROACH: Local communities will be surveyed for location of mosquito-producing situations. Species found will be identified when vital information is lacking for any species found to be a problem, appropriate research on seasonal history, preferred breeding sites and methods of control will be initiated. Local personnel will be trained to carry out routine organized control programs. Local groups will be assisted in organizing mosquito-abatement districts.

2. AQUATIC PEST CONTROL

SUPPORTED BY Arkansas State Government - Little Rock

2.0005, CONTROL OF COMMON HOUSEFLY
J.S. SIMCO, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville, Arkansas* 72701 (ARK00686)

OBJECTIVE: Develop a housefly control program in all areas of agriculture based on minimal use of insecticides. Restudy the biology and ecology of the housefly with particular reference to segments of the life cycle which may be vulnerable to new control concepts. Develop a control program for the soldier fly larva in cage layer houses. Observe and study other insect breeding in manure in cage layer houses. Determine the mosquito species, distribution and abundance on an organized basis.

APPROACH: Determine insecticide minimal usage requirements for adequate housefly control. Chemical sterilants will be tested. Screening of various insecticides to determine effectiveness against the soldier fly larva and other manure breeding insects in caged layer operations. Collection trips will be made to collect mosquitoes especially in those areas where there are no records or where the records appear inadequate. Special surveys will be made to evaluate the effectiveness of control programs.

PROGRESS: Gardona Capsules were fed in a complete layer ration at rates of 400 ppm and 200 ppm for the control of Housefly Larvae Under Cage Layers. The results from the ration containing 400 ppm was very promising in that it gave better than 95 percent control for the 4 week test period. The ration containing 200 ppm gave approximately 75 percent control during the 4 week test period. Mosquito control tests in small plots on the Rice Branch Experiment Station were carried out using 2 x 4 blocks soaked in heptachlor, malathion, parathion and Dursban EC. Sixty larvae were found 4 days after flooding in the heptachlor plot; 3 in the malathion and none in the parathion or Dursban treatment. However, the check plot also had none.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0006, BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA
C.B. HUFFAKER, Univ. of California, Agricultural Experiment Sta., *Berkeley, California* 94720 (CA-B0-BIC-2428)

OBJECTIVE: Comprehensively evaluating the ecologies and efficacies of existing natural control, introducing certain foreign parasitic, predatory, or pathogenic species, measuring consequent performance in succeeding years, augmenting the efficacies of existing or introduced natural enemies by environmental manipulations, and assist in the development of integrated control programs aganist certain mosquito species by investigation of those biological and environmental control agents or practices that will best lend themselves to this end.

APPROACH: One or more aquatic environments will be selected where major mosquito problems exist and where the best opportunities lie for developing a biological control phase of an integrated control program.

PROGRESS: Field investigations were started for the control of snow mosquitoes in the South Lake Tahoe area because of a possible scale outbreak in the pines due to previous mosquito control techniques (Malathion fogging). Laboratory investigations with rainbow fingerling trout and Lake club minnows indicated they were voracious mosquito predators at low temperatures (4 C). Preliminary field studies indicated control possibilities with these fish in semi-permanent snow water ponds. A survey of aquatic arthropods, their role as possible predators, and their distribution in various water sources formed from melting snow was initiated. An aquatic light trap was developed and tested and found to be more sensitive than the standard dipping technique for Aedes spp. and Culiseta spp. and at least comparable to dipping for Culex spp. and Anopheles spp. This technique eliminates certain human biasis associated with dipping, as well as, attracts a wide variety of other aquatic arthropods. Feeding behavior of Aedes aegypti on immature insects was studied under control conditions. These studies revealed that the stimuli associated with the investigator rather than those associated with the immature insects induced the feeding response. Desiccation of the mosquitoes was also found to be very important (A. aegypti studies with J. Laing).

SUPPORTED BY California State Government - Sacramento

2.0007, TO CHARACTERIZE PATHOGENS OF MOSQUITOES
E.L. REEVES, Univ. of California, Agricultural Experiment Sta., *Berkeley, California* 94720 (CA-B-PAR-2418)

OBJECTIVE: Identify and characterize pathogens, including viral, fungal, bacterial, protozoan, and/or nematode infections which affect mosquitoes; provide information thereon for use in development of biological agents for control of mosquitoes in irrigated farming areas; conduct laboratory investigations to establish the mosquito-pathogen relationships of material collected.

APPROACH: Correlate, analyze and evaluate data obtained from samples of naturally infected mosquito populations collected from typical breeding areas in California, and to determine the species of mosquitoes which are infected by the pathogens and conduct microscopic examinations of specimens to identify for each species the type of pathogen causing the infection.

PROGRESS: Research is being concentrated on two mosquito pathogens. (1) Mycotoxins extracted with organic solvents from Aspergillus flavus are being chemically characterized and bioassayed against mosquitoes with favorable results. (2) Toxic metabolites from five isolates of green and blue-green algae are being isolated, characterized and bioassayed against mosquitoes with excellent results.

SUPPORTED BY California State Government - Sacramento

2.0008, BIOLOGY AND CONTROL OF PASTURE MOSQUITOES
C. SCHAEFER, Univ. of California, Agricultural Experiment Sta., *Berkeley, California* 94720 (CA-B0-PAR-2454)

OBJECTIVE: Study various aspects of the biology of pasture mosquitoes so that more effective cultural control measures can be developed for those species. Prepare a comprehensive report on the biology of these mosquitoes which can be used by workers engaged in such cultural control.

APPROACH: Initially a comprehensive report on the relation between these mosquitoes and pasture irrigation will be developed. Studies will then be undertaken to clarify the relation between such factors as duration of ponding and developmental rate of mosquitoes at various temperatures and seasons and how this may be influenced by various irrigation practices.

PROGRESS: A new carbamate (Chevron, REI1775) was discovered which shows high potential for controlling both larvae and adults of susceptible and organophosphorus resistant strains of Aedes nigromaculis. Extensive laboratory and field studies with the new compound were conducted in 1969. Laboratory tests indicate that REI1775 will also be effective for controlling organophosphorus-resistant Culex tarsalis larvae. A study was made to determine why Dursban has a long residual toxicity to mosquitoes when applied to highly-polluted water, since this does not occur when it is applied to cleaner water, e.g., irrigated pastures. Laboratory and field studies demonstrate that, when Dursban is added to a body of water, it quickly becomes distributed throughout the water and then adsorbs onto organic matter. Dursban is lost by hydrolysis within a few days, if it remains in water, but provides residual toxicity for many weeks if it deposits on organic matter. Further studies on the biology of Aedes melanimon help to explain the fall dispersal of this species. In the fall, the extent of nocturnal flight increases greatly and the bimodal peaks of flight activity (at twilight periods), which are characteristic in the spring and summer, are reduced. In the fall, a much greater number of adults can be collected with unlighted, unbaited traps, which indicates a non- specific flight behavior. Wind of 5 mph or more seems to inhibit flight.

SUPPORTED BY California State Government - Sacramento

2.0009, AERIAL DISPERSAL METHODS FOR CONCENTRATED INSECTICIDES
N.B. AKESSON, Univ. of California, Agricultural Experiment Sta., *Davis, California* 95616 (00ENTH01090508CO)

OBJECTIVE: Develop and evaluate methods of aerial application of various insecticide formulations as concentrated or undiluted sprays for control of mosquitoes.

APPROACH: Design and/or utilize effective aerial spray systems to apply low volumes of concentrated insecticide materials. Evaluate promising insecticides against mosquito larvae and adults breeding in irrigated pastures by aerial application low volume techniques.

PROGRESS: Low-volume applications have demonstrated good mosquito control in rice fields and pastures treated by helicopter in the Colusa area, including the Colusa Wildlife Refuge. Dursban was applied at 0.05, 0.025, and 0.0125 lb/acre and fenthion at 0.1 lb/acre. The swath width was 250 feet and a volume of 6.1 fluid oz/acre was applied. So far, during studies of possible effects on bees and wildlife, no damage has been noted. In cooperation with the U.S. Navy and the California Bureau of Vector Control, studies were made in Kern County to determine whether low-volume applications could be successfully made at altitudes of 1,000 and 2,000 feet. Both larvae and adult mosquitoes were killed from altitudes up to 2,000 feet over swaths extending 1/2 mile wide at dosage rates less than 8 fluid ounces per acre.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0010, INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS

R.M. BOHART, Univ. of California, Agricultural Experiment Sta., *Davis, California* 95616 (CA-D0-ENT-2640)

OBJECTIVE: Obtain basic information on insects affecting man and animals by irritation or by transmission of disease. Develop new methods of reducing noxious arthropods to acceptable levels.

APPROACH: Develop new techniques to manipulate the insect's environment so as to reduce the population through biological or chemicobiological means, or the alteration of feeding or reproductive behavior of the pest in such a way as to reduce attack on man and animals below an acceptable level. Another approach is to find methods of keeping pestiferous insects in recreational areas below tolerable levels. Also, to employ pesticides in combination with water use management to minimize resistance of mosquitoes to chemicals and to reduce associated crop residue problems.

SUPPORTED BY California State Government - Sacramento

2.0011, BIOLOGY AND CONTROL OF MOSQUITOES IN IRRIGATED AND WATER MANAGEMENT AREAS

W.M. ROGOFF, U.S. Dept. of Agriculture, Entomology Research Division, *Fresno, California* 93727 (00ENTH0104051000)

OBJECTIVE: Determine biology and habits of mosquitoes associated with irrigated areas; investigate water-management procedures in relation to mosquito abundance and control. Develop chemical, non- chemical, and integrated control methods and materials for irrigation produced mosquitoes.

APPROACH: Collect, identify, and determine abundance and distribution of mosquitoes under various types of irrigation and water management procedures; identify and measure ecological limiting factors. Test chemical, non-chemical, and integrated control measures in irrigated or water management areas by routine field trials.

PROGRESS: Tests in cooperation with Fresno Westside Mosquito Abatement District showed that rice paddies stocked with Gambusia affinis showed 99% control of Culex tarsalis at a stocking rate of 1000 fish per acre and 95% control at 200 fish per acre. Larger scale tests are underway at 100 and 200 fish per acre in Fresno County and Yuba County. Heads, thoraces, and abdomens of male southern house mosquitoes in olfactometers were comparably attractive to females of this species. Some dioxane and dioxaspiro derivatives and 4 phenolitic compounds from Douglas fir bark showed a low level of attraction for males. An 8' x 12' x 7' screened cage has been constructed for rearing Aedes nigromaculis. Artificial treeholes have been constructed for studies with Aedes sierrensis. Colonies of Culex tarsalis, C. p. quinquefasciatus, and A. sierrensis have been established. Preliminary studies with juvenile hormone mimics have established provisional dosages for field studies.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0012, SUPPLYING GENETIC MARKER AND INCOMPATIBLE STRAINS OF CULEX PIPIENS

A.R. BARR, Univ. of California, School of Public Health, *Los Angeles, California* 90024 (NIH-70-2099)

Independently and not as an agent of the Government, the Contractor shall exert its best efforts to maintain stocks of 'Culex pipiens' mosquitoes and to make them available upon request to qualified investigators. The Contractor will keep sufficient stocks of these mosquitoes to supply those requests approved by the Project Officer. The actual number of each strain will vary according to the demands of the scientific community and as mutually agreed to by the Project Director and the Project Officer.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

2.0013, CYTOPLASMIC INCOMPATIBILITY FOR FILARIASIS CONTROL

A.R. BARR, Univ. of California, School of Public Health, *Los Angeles, California* 90024

Cytoplasmic incompatibility is being investigated for the control of mosquitoes by the 'sterile male' principle. The emphasis during the year was on the relation between partial compatibility and incompatibility in Culex pipiens. A partially compatible crossing is being selected for incompatibility. Electron micrographs of imcompatible fertilizations have failed to show any reaction between the mutually imcompatible sperm and egg cytoplasm. Some progress was made in the study of inheritance of a sex ratio distorting factor which produces an excess of male offspring.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. -
H.S.M.H.A

2.0014, BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES

E.C. BAY, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R-BIC-2032)

OBJECTIVE: Fish, predaceous invertebrates, including arthropods, and microorganiss destructive to aquatic pest Diptera are to be sought and evaluated for their ability to control these insects in a variety of environments. Also, to be studied will be the effect of certain aquatic plants in relation to the breeding sites of pest Diptera.

APPROACH: The work proposed is to be conducted in controlled aquatic habitats established at Riverside, and in sewage oxidation ponds at Palm Springs and Ontario, California. The population dynamics among pest Diptera and their candidate natural enemies are to be studied within confined, insect-screen enclosed ponds receiving filtered water. The environments of these ponds will be managed to represent the various conditions encountered at sites of aquatic insect nuisance in southern California.

PROGRESS: LARVIVOROUS FISH: The guppy Poecilia reticulatus was studied according to sex and age structure for feeding capacity on various instar mosquito larvae with and without alternative food. Results to be summarized. Similar studies made with Cynolebias wolterstorffi, Cyprinodon nevadensis and Gambusia affinis. P. reticulatus was found to survive in many but not all agricultural waste- water larval breeding sites into which they were introduced. P. reticulatus will not overwinter in southern California but small spring releases reproduce to control larvae in some breeding sites by mid- August. Twenty-five female P. reticulatus introduced into an Orange County domestic sewage oxidation effluent on 11 July reproduced to several thousand fish before winter kill on November 27. By 18 August fish controlled all but first instar larvae while in adjacent check pond all instars present. INVERTEBRATES: Hydra americana was critically studied and found a remarkably effective mosquito larva predator under proper conditions. Notonecta unifasciata was studied in field aquaria for ability to control daily recruited mosquito larvae (Culex peus) with and without alternative prey (Chironomidae) present. During June-July, larval control by Notonectids was 40% with 9-day delayed predator introduction and 77% with simultaneous initial predator-prey introduction followed by daily prey recruitment. Chironomid prey did not reduce predation on mosquito larvae.

SUPPORTED BY California State Government - Sacramento

2.0015, EVALUATION OF NEW INSECTICIDES

T.R. FUKUTO, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-1415)

OBJECTIVE: About 800 to 1000 new chemical compounds are received each year from more than 20 firms. These are evaluated in routine laboratory tests for potential promise as insecticides, especially for use against resistant species if insects. The more active compounds are evaluated in a variety of special operations to determine their suitability for field testing.

APPROACH: Work of the same general nature will be carried on during the forthcoming year.

PROGRESS: New insecticidal compounds synthesized in our laboratories or received from chemical manufacturers continue to be evaluated in the laboratory in a variety of tests, particularly on insecticide-resistant house flies and mosquitoes and as systemic insecticides on cotton, as a screening procedure for the identification of compounds meriting more complete laboratory and field evaluations including comparative metabolism studies. Nearly 100 compounds have been initially evaluated in the past year including phosphorothioates, phosphonothioates, phosphoramidothioates, and their oxygen analogs, oxime phosphates, N-methyl carbamates and their acylated or phosphorylated derivatives, and miscellaneous compounds including a synthetic juvenile hormone. A number of the compounds have been selected for further evaluation including Stauffer R-18060, Bayer BAY 77488 and BAY 99485, Ortho 9006 (Monitor(Reg)), and a series of N- phosphorylated N-methyl carbamates.

SUPPORTED BY California State Government - Sacramento

2.0016, NEW INSECTICIDES & TECHNIQUES FOR PEST CONTROL

G.P. GEORGHIOU, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R-ENT-1947)

OBJECTIVE: Laboratory and field investigations of more compounds as toxicants for larval and adult mosquitoes.

APPROACH: Larvicidal compounds evaluated against the top minnow, and several species of frogs for potential damage to wildlife. Materials in water and soil studied in relation to possible water pollution. The residue persistence curves for alfalfa treated with parathion and Baytex evaluated using sprays and granulars. Compare penetration of vegetative plant cover by granulars and sprays.

PROGRESS: With the departure of Dr. R.L. Metcalf to the University of Illinois and the transfer of the World Health Organization Program to that Institution, the routine screening of new compounds against mosquitoes has been discontinued. Emphasis is now placed on the examination of selected new compounds which hold promise as mosquito control agents, or which by virtue of their chemical configuration can provide useful information on mechanisms of cross resistance.

SUPPORTED BY California State Government - Sacramento

2.0017, STUDIES ON INSECTICIDE RESISTANCE IN MOSQUITOES

G.P. GEORGHIOU, Univ. of California, School of Agriculture, *Riverside, California* 92502

Research under this project is aimed at elucidating the toxicological, physiological, biochemical, and genetic bases of mosquito resistance to insecticides. This information is of value in the more efficient utilization of existing insecticides and synergists, and in the development of promising new ones. Areas of continuing emphasis include the characterization of potential resistance to organophosphorus and carbamate insecticides of current or expected future value in vector control and eradication programs. These studies utilize the species Culex quinquefasciatus (equals fatigans), Culex tarsalis, and Anopheles albimanus. Pure strains of these species are developed by selection pressure and by genetic manipulation, and the mechanisms of resistance are investigated. A strain of A. albimanus with high resistance to organophosphates and carbamates has been developed. Similarly, a strain of Culex tarsalis with stable, high organophosphorus resistance has been colonized. Research will concentrate on the biochemical and genetic characterization of resistance in these strains.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - H.S.M.H.A

2.0018, SUPPRESSION AND ECOLOGY OF MOSQUITOES

M.S. MULLA, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2465)

OBJECTIVE: Study and develop integrated and coordinated mosquito control technology. Assess the potential use of new pesticidal measures and to improve currently much practiced techniques. Initiate studies on mosquito sex pheromones and other attractants, with the aim of utilizing these for control purposes. The relationship of environmental factors both biotic and physico-chemical to mosquito production in selected niches will be studied.

APPROACH: A multipurpose and practical mosquito control technology will be advanced emphasizing new approaches and working towards improvement and streamlining of currently used techniques. Laboratory and field evaluation of the biological activity of various types of compounds against various stages of various species will be continued. Studies will be conducted on the potential use of chemical sterilants for autocidal measures. A program to assess the efficacy of petroleum oils against various stages of mosquitoes is to be continued. Attractants and sex pheromones of mosquitoes will be studied. Research on a new group of simple and readily available chemicals, the organic amines, will be advanced.

PROGRESS: During 1969, the mosquito Culex tarsalis became resistant to organophosphate materials used for the control of this species. This tolerance was extended to some other organophosphates too. Resistance in the pasture mosquito Aedes nigromaculis to organophosphate compounds also reached a high level. Aerial application and drip application of some organophosphate insecticides were ineffective. However, Akton, Supracide, Bay 78182, Bay 77488 and Chevron RE-11775 were effective against these resistant mosquitoes at the rate of 0.1 lb/acre or so. The occurrence of chemical factors produced by mosquito larvae reared under overcrowded conditions was established. These factors caused mortality delayed development and other abnormalities in succeeding generations. These factors showed extra-specific activity against other species of mosquitoes. Oviposition attractants for the mosquitoes Culex tarsalis, Aedes nigromaculis and Ae. taeniorhynchus were found. Cross activity of these attractants was studied. Some were specific for some species and others were non-specific.

SUPPORTED BY California State Government - Sacramento

2.0019, MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS

E.L. REEVES, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2429)

OBJECTIVE: Detect, identify and evaluate the naturally occurring pathogens of mosquitoes in California. the results from the field and laboratory studies of these pathogens and their associated epizootics will be incorporated into a biological control program for mosquitoes.

APPROACH: An intensive survey will be made of mosquito habitats. Determine the presence of any diseases occurring in epizootic form. Field collected mosquitoes will be stressed in the laboratory to reveal latent disease. Hosts will be examined histologically to determine target tissue and host-pathogen relationships. The life cycle of the newly acquired pathogens will be elucidated. Foreign exploration will be conducted as required to obtain promising microorganisms.

PROGRESS: 1) A virulent spore-forming crystalliferous Bacillus, BA-068, an effective pathogen against mosquito larvae of the genus Aedes, including A. aegypti, nigromaculis, sierrensis, and triseriatus, has been isolated and evaluated. BA-068 consistently produces two parasporal crystals, and is readily cultured on laboratory media. Bioassays against Aedes larvae show 97-98% mortality in lst-instar with 0.9 x 10 spores/ml; in 3rd-instar with 4.5 x 10 . Preliminary field tests against insecticide resistant A. nigromaculis larvae in Tulare and Kern Co. showed good results. 2) Laboratory evaluation of 5 species of mucilaginous Cruciferae seeds has been completed. This has potential as a biological control method for mosquitos in certain habitats. 3) Seven species of larvicidal algae (2 Chlorophyta, l Cyanophyta, 4 Charophyta) that release toxic substances into the aquatic habitat which inhibit the development of immature mosquitoes have been isolated, identified, and evaluated. The toxic fractions have been extracted from each and chromatographically pure material bioassayed against lab reared and field collected mosquito larvae. They were especially toxic to larvae of A. aegypti and A. nigromaculis. In practical application, these algae could be propagated in rice-fields, ponds, etc, to suppress larval populations; or the active compounds could be characterized, synthesized, and dispersed like other insecticides. No adverse effects to fish or aquatic insect predators have been detected.

SUPPORTED BY California State Government - Sacramento

2.0020, IDENTIFICATION AND CHARACTERIZATION OF MOSQUITO PATHOGENS

R.L. REEVES, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (00ENTH01100519CO)

OBJECTIVE: Discover and identify pathogens affecting mosquitoes and investigate their effects. Evaluate potential of biological agents for control of larvae and adults of mosquitoes.

APPROACH: Survey natural mosquito breeding areas, collect specimens to determine infected mosquito species, infection rates, and species of pathogens present. Determine life cycle of pathogens (virus, fungus, bacterium, protozoan, or nematode) and mechanisms for infecting mosquitoes.

PROGRESS: At Riverside, Calif., four isolants of Christoliphoris bacillus, each from different field collected mosquitoes, are being investigated. A large percentage of field populations is infected and mortality was high. A metabolite produced by an Aspergillus was found to be highly toxic to mosquito larvae. Purification and identification of this in additional metabolites is continuing as are infectivity tests against other species of mosquitoes. Five isolates of field-collected green and blue-green algae produced metabolites toxic to mosquito larvae. Field observations that suggested a close correlation between the presence of certain algae and absence of mosquito breeding were confirmed by tests giving 98 to 100% mortality of third stage Culex tarsalis and C. pipiens quinquefasciatus larvae placed in filtered water from pools containing the algae.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0021, INVESTIGATIONS OF PHEROMONES AS CHEMOSTERILANTS FOR INSECTS WITH SPECIAL REFERENCE TO SYNTHETIC QUEN SUBSTANCE AND ITS ANALOGUES

A.J. THORSTEINSON, Univ. of Manitoba, Graduate School, *Winnipeg, Manitoba, Canada* (DADA17-68-G-9267)

Objective: To study the biochemical and physiological mechanisms concerned with the inhibition of ovarian growth egg laying, hatching, and mating behavior of 9 oxodec trans 2 enoic acid and its analogues when applied to insects for control in military situations.

Approach: The subject compound and analogues will be obtained and injected into, fed to, or placed upon various stages of insects after which various biological activities will be studied to determine the results of the exposure particularly as related to mating behavior, sexual development, and metamorphosis.

Progress: Several pheromone analogues were selected in the laboratory for rapid kill of immature mosquitoes and were applied in fuel oil in the field with promising results. Laboratory studies have shown that the same compounds are much more effective when applied in alcohol solutions. This procedure is a very convenient laboratory screening method, however, the use of a lipid stain has shown that the spreading properties of alcohol solutions appear much more suitable, perhaps even for field applications, than fuel oil of similar dilutents. These are reasons for suggesting that the increase cost of alcohol diluent may be more than offset by its greater effectiveness and spreading properties. In addition the pollution of water and air is negligible compared with petroleum diluents. Efforts have returned to the search for materials that cause more subtle disruptions of mosquito development. These chemicals hold more promise for avoiding injury to beneficial species that visit the air-water interface. It has been found that queen substance, farnesol and oletic acid delay moulting at the third and fourth larval instar. Ovoposition of females is also behaviorally inhibited by the same substances applied to the water surface. An interesting effect was observed when queen substance was applied at 0.0025 M to larvae deprived of food - these survived longer than larvae in the control sets. The investigators are proceeding to test derivatives of queen substance and other unsaturated fatty acids, juvenile hormone analogues as well as other terpenoids.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0022, BIOLOGY OF MICROORGANISMS OF MOSQUITOES

J.F. ANDERSON, Univ. of Connecticut, Agricultural Experiment Sta., *Storrs, Connecticut* 06268 (CONH00320)

OBJECTIVE: Survey populations for the presence of pathogenic microorganisms, and identify the pathogens; study interrelationships of pathogen and host and physiological effects of the pathogens, evaluate the epizootiology of parasites on populations of mosquitoes; develop culture methods for pathogens and effective procedures for their use.

APPROACH: Collect mosquitoes and identify pathogens; determine the manner in which pathogens affect host; determine the factors necessary for a pandemic of the pathogens in mosquito larvae; attempt culture of pathogens; introduction in field populations of mosquitoes.

PROGRESS: Entomophthora aquatica, a fungal pathogen of Aedes canadensis, was successfully subcultured on unsolidified egg yolk medium. Normal appearing hyphal bodies are produced, though abberant ones are often encountered. Spores have not been produced in this medium. A Bacillus bacterium was isolated from the salivary glands of larvae of Aedes canadensis. Infection results in death of the mosquito. An iridescent virus with a particle size of 135-140 mu was isolated from larvae of Aedes stimulans. Larvae usually died just before or during ecdysis into the fourth instar. Infected larvae are recognized by an opalescent turquoise color. Virus occurred in the cytoplasm of the pericardial cells, oenocytes, and cells of the epidermis, sarcolema, fat body, ovaries, testes and imaginal discs. The incidence of infection in four woodland pools was less than one percent. The virus was named Aedes stimulans iridescent virus.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0023, DEVELOPMENT AND BEHAVIOR OF BITING DIPTERA

J.F. ANDERSON, Univ. of Connecticut, Agricultural Experiment Sta., *Storrs, Connecticut* 06268 (CONH00312)

OBJECTIVE: Determine if deer flies can be managed in an urban environment by trapping the adults on large colored objects; determine the role of photoperiod in governing the seasonal cycle of mosquitoes.

APPROACH: Two species of deer flies are a problem to more than 500 families in one of our shoreline communities. Traps designed to capture female deer flies will be placed in specific areas to determine if populations of deer flies can be reduced to non-annoyance levels. Photoperiod determines in large part the seasonal histories of several of our major pest mosquitoes. The critical day length and sensitive stages of growth of some species will be determined. Histological and transplantation techniques will be used to ascertain the endocrine basis of diapause.

PROGRESS: The effect of duration of daylength on induction of diapause in Connecticut and Florida strains of Aedes solicitans was studied. Diapause was not induced in the Florida strain by short photoperiod. Diapause was induced in the Connecticut strain. The critical period of light reception occurred during the fourth larval instar, pupa, adult, developing embryo and fully formed embryo. The effect of photoperiods of 14 hours or more were shown to be independent from that of low temperature, thereby emphasizing that the deposition of diapausing eggs during fall is clearly in expression of the influence of shorter days of the mosquito. Fully formed embryos developing under a long day enter a diapausing state within 21 days when stored under a short photoperiod and temperature of 65 . This reaction accounts for the lack of hatching of summer deposited eggs in late fall. Diapausing eggs are reactivated when stored at temperatures of 5 for four weeks and subsequently exposed to long day photoperiods for two days at 73 . Chrysops atlanticus was found to be attracted to large black objects when placed six feet above the ground. Efforts are under way to suppress populations of deerflies by trapping.

SUPPORTED BY Connecticut State Government - Hartford

2.0024, TESTING ADULT ATTRACTION DEVICES AND CHEMOSTERILANTS FOR TABANID FLY CONTROL

E.P. CATTS, State Div. of Fish & Wildlife, *Dover, Delaware* 19901

Objectives: 1. To explore the use of chemosterilant (e.g. Metepa) in combination with carbon dioxide-canopy traps as a means of local tabanid fly control. 2. To complete the study of the ecological distribution of hunting tabanid flies on and near salt marsh.

Procedures: One canopy trap with a delaying release chamber coated with Metepa will be erected twice weekly on each of two small test marshes. Collections with similar untreated canopy traps will be made from two different marshes, and compared to the test areas. Some wild caught flies exposed to chemosterilant will be held in the lab and their longevity compared to unexposed wild caught flies. Egg mass sampling and counts will be made and compared for all four salt marshes. Some egg samples will be held in the lab to determine fertility and viability. Attempt will be made to determine oogenic history of flies exposed to chemosterilant in canopy traps by determining parity.

Sampling of hunting salt marsh tabanids using carbon dioxide-canopy traps at different habitat sites will be continued from July through August 1970. Comparison of the two season's data will be made and prepared for publication.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0025, INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES

R.W. LAKE, Univ. of Delaware, Agricultural Experiment Sta., *Newark, Delaware* 19711 (DEL00728-A)

OBJECTIVE: Study the effectiveness of control methods by trapping adult mosquitoes; the toxicity of insecticides to possible resistant and non-resistant mosquitoes, and to muskrats; and ditching of salt marshes as a control method.

APPROACH: Light trapping of adult mosquitoes with New Jersey light traps. Field and laboratory tests of promising insecticides. Determine resistance of pest species to insecticides with WHO test-kits. Ditching studies of standard and large (up to 15 feet wide) ditches.

PROGRESS: Excessive rainfall during July 1 & Sept. 1969 was responsible for the high light trap counts of Aedes vexans and Culex spp. plus miscellaneous flood-water species. Aedes sollicitans although trapped in greater numbers this year accounted for only 8% of the total female mosquitoes collected. The efficient larviciding operations with Abate plus the continued water management operations have tended to markedly reduce the A. sollicitans pest problem. Additional trapping and larval survey work were undertaken in order to gain a better understanding of EE epidemiology in Delaware. Results of wildlife toxicological studies showed that Bay 77488 ULV up to 1 fl. oz./A resulted in little or no mortality to killifish (Fundulus heteroclitus). Baygon produced no significant mortality with dosages up to 6 fl. oz./A. Large scale field tests utilizing fixed-winged aircraft to apply Baygon ULV, 3 fl. oz./A, over fields, adjacent to the salt marsh, indicated an average reduction of adult mosquitoes of 95.4%. Aedes, Anopheles, Culek and Psorophora species were all present with A. sollicitans being predominant. Dibrom (naled) at .05 lb./A continues to be an effective adulticide, applied by aircraft, as indicated by tests against high populations of A. sollicitans & other pest species. Field tests with Abate ULV at 1 fl. oz./A as a larvicide confirmed the excellent control results obtained with this formulation in 1968.

SUPPORTED BY Delaware State Government

2.0026, INVESTIGATIONS OF THE ACTION OF CHEMOSTERILANTS ON HOUSEFLIES AND OTHER MEDICALLY IMPORTANT ARTHROPODS

G.C. LEBRECQUE, U.S. Dept. of Agriculture, *Gainesville, Florida*

Objective: This project is to investigate the action of chemosterilants on houseflies and other medically important arthropods and evaluate their potential for use in military disease control programs.

Approach: The plans include studies to determine the cytological action of the active compounds and field evaluations of their effectiveness in control programs.

Since the beginning of this research program approximately 8,000 compounds have been screened, with approixmately 400 showing positive sterilization characteristics in laboratory tests and 10 showing encouraging results in field tests. A recent field test was just completed using the chemosterilant Thiopeta in pupal water which resulted in the eradication of the mosquito Culex pipiens quinquefasciatus from Sea Horse Key Island, which is located just off the gulf coast, west of Gainesville, Florida.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0027, BIOLOGICAL CONTROL OF INSECTS AFFECTING MAN

D.E. WEIDHAAS, U.S. Dept. of Agriculture, *Gainesville, Florida*

Objective: This study is concerned with the utilization of biological organisms for the control of medically important arthropods and the development of techniques suitable for their use in control programs.

Approach: Known pathogens parasites and predators are to be considered from the standpoint of rearing and adaptibility to releasing procedures. Studies are to be made on the biology of the control organism, its relationship to the host methods of cultivation release and establishment in the environment.

One bacteria, two fungi, three viruses, and four microsporidian insect pathogens are presently under investigation. The most promising laboratory results have been obtained with the microsporidian Nosema, sp., where 70-90 percent mortality has been obtained against Anopheles quadrimaculatus. No field trials have been initiated.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0028, SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE

F. ACREE, Univ. of Florida, U.S.D.A. Entomology Res. Div., *Gainesville, Florida* 32601 (00ENTM0202100100)

OBJECTIVE: Develop safe effective chemical agents and formulations for control of insects affecting man.

APPROACH: Prepare or formulate organic compounds of various types in suitables form, for biological screening tests as insecticides, synergists, repellents, attractants, or other types of insect control agents. Investigate effects of type of formulation and method of application on effectiveness of compounds in controlling or repelling insects. Develop methods for assay of insecticide and repellent formulations used for protection of personnel. Investigate other physical and chemical factors involved in effectiveness of insect control agents.

PROGRESS: To measure the attraction of human emanations to mosquitoes a method has been developed for determination of carbon dioxide from hands using an MSA infrared gas analyzer. Data have been collected under test conditions for treated and untreated hands with many subjects. A method for determination of lactic acid by GC is being developed. Preliminary work has begun on the following: (1) chemical analysis of fats in vigorous mosquitoes; (2) air sampling for aerial application of pesticides; (3) test method by GC for rancidity in the fire ant bait soybean oil.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0029, INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS

L.C. KUITERT, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (00ENTH01071001CA)

OBJECTIVE: Provide more effective, efficient, and standard methods of measuring levels of insecticide resistance in house flies to evaluate gamma radiation as a sterilizing agent for the mosquito, Culex quinquefasciatus; and determine the genetic basis of resistance to sterilants.

APPROACH: Originate and maintain resistant and susceptible house fly and yellow fever mosquito colonies for use in measuring resistance levels by laboratory techniques. Produce genetically marked strains by breeding selections for the purpose of studying genetic mechanisms of resistance.

PROGRESS: A colony of Culicoides guttipennis was established and is being maintained in the laboratory. Attempts to establish a colony of Culicoides arbovicola in the laboratory have been unsuccessful. Artificial media have been developed for rearing 3 treehole species of Culicoides in the laboratory. The media base consisted of hay fusion, yeast, liver extract, and dried milk solids. Immunodiffusion tests comparing the R and T isolates of mosquito iridescent virus from Aedes taeniorhynchus were completed. Four different antigens were detected; each of which was present in both viruses. No differences could be detected between the two viruses by this technique. Inspection of different tissues of 4th instar larvae indicated the virus to be in fat body, trachial matrics, epidermis, nerves, and haemocytes but not in midgut, gonadial tissue, or malphigian tubules. So far, no virus has been seen in larval gonadial tissue although mosquito iridescent virus is known to be transmitted transovarially in the adult.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0030, INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY

D.A. LINDQUIST, Univ. of Florida, U.S.D.A. Entomology Res. Div., *Gainesville, Florida* 32601 (00ENTS0101100100)

OBJECTIVE: Develop information on insect attraction and other aspects of behavior that may be used to devise selective methods of insect control which avoid or reduce hazard of using chemicals toxic to plants or higher animals.

APPROACH: Basic studies will be conducted on the sense organs and pheromone-producing organs of insects and correlated with biological, behavioral, and ecological studies of specific responses. Attractants, arrestants, and locomotor, feeding, mating, and oviposition stimulants will be studied.

PROGRESS: Laboratory studies with the sex pheromone of the cabbage looper, Trichoplusia ni, indicate that the male looper moth is not attracted to the pheromone in total darkness but is attracted to the pheromone in dim light. Ultraviolet light traps baited with the cabbage looper pheromone caught looper moths in every month indicating that this species overwinters in the Gainesville, Fla. area. The scanning electron microscope has made it possible to observe and describe several new sensors on the antennae of various species of insects which may be associated with infrared communication systems of insects. Adult female Aedes aegypti mosquitoes and fed adult female lone star ticks, Amblyomma americana, both responded to 10.6 micron infrared radiation from a CO(2) gas laser. A male attractant for the house fly, Musca domestica, was found in house fly feces. Partial chemical characterization indicated that the active compound(s) is a neutral lipid.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0031, CULTIVATION OF COELOMOMYCES, A FUNGAL PARASITE OF MOSQUITOES

J.T. MULLINS, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-BT-01387)

OBJECTIVE: Develop ways of culturing the fungus in quantities sufficient for use in vector control operations.

APPROACH: Research will be directed toward the laboratory infection of isolated cells derived from tissue cultures of mosquitoes. Observations will be made on how the fungus enters the host cells and the subsequent development of the pathogen from its initial penetration to the maturation of sporangia. An effort will be made to determine the host range of various species of Coelomomyces. Research will be directed toward cultivation of the fungus on nutrient media in the absence of host cells. A variety of supplements including both natural products from mosquitoes and chemically defined species will be screened for their effectiveness in supporting growth.

PROGRESS: Field collections of mosquitoes infected with Coelomomyces have again been made this year in the Gainesville, Florida, area. The fungus has persisted in the same areas and becomes apparent when larvae of Psorophora are produced. This documentation of the survival of the parasite in nature greatly enhances the possible utilization of Coelomomyces for the biological control of mosquitoes. The key glycolytic enzymes from both infected and non-infected larvae have been extracted and analyzed. No significant differences have been detected in these preliminary experiments between infected and non- infected larvae. In addition to unusual pathways are evident in the infected larvae. Thus it appears that this group of enzymes will not provide any specific clues to possible methods of cultivating the fungus on synthetic media. Other possible enzymatic pathways of key nutritional enzymes are being looked at in the hope of finding a means for the laboratory cultivation of this fungus.

SUPPORTED BY Florida State Government - Tallahassee

2.0032, CONTROL OF CULEX NIGRIPALPUS BY STERILITY METHODS

W.W. SMITH, Univ. of Florida, Inst. of Food & Agric. Sci., *Gainesville, Florida* 32601

The objective of this project is the demonstration of the control of a natural population of Culex nigripalpus by use of sterility techniques. Chemosterilants are the agents to be used for the production of sterility in individual mosquitos treated for inundative releases.

The project objective is to be attained by the following steps: 1. Establishment of a self-perpetuating laboratory colony of Culex nigripalpus. 2. Development of methods producing uniform specimens for testing of representative chemosterilants for effective, non-reversible sterilization without too great impairment of mating competitiveness. 3. Selection of the most desirable chemosterilant for use in the project. 4. Development of mass production and mass sterilization methods. 5. Establishment of self-perpetuating populations of Culexnigripalpus in known numbers in large outdoor cages. This may involve the introduction of wild field strains into the laboratory stock. 6. Determination of proper ratios of treated to untreated specimens to obtain control of the populations in the outdoor cages. 7. Location of an isolated natural population of Culex nigripalpus and demonstration of its control by inundative releases of sterilized individuals.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. -
H.S.M.H.A

2.0033, BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS

D.E. WEIDHAAS, Univ. of Florida, U.S.D.A. Entomology Res. Div., *Gainesville, Florida* 32601 (00ENTH0101100100)

OBJECTIVE: Determine distribution, abundance, taxonomy, and ecology of mosquitoes, sand flies, and gnats, how to control by insecticides, chemosterilants, repellents, attractants, pathogens, predators, and parasites for public and military programs.

APPROACH: Determine population dynamics in nature, especially by sterility and other markers, test and evaluate potential chemical, physical and biological control measures, develop basic information on taxonomy and ecology of the insects by laboratory and field methods.

PROGRESS: The sterile-male release technique was used against a small island population of southern house mosquitoes to determine total population numbers, biotic increases, and survival pattern. The natural population of approximately 10,000-

20,000 individuals represented emergence rates of 2500 to 5000/day. Biotic increases of 1- to 3-fold per generation reached a maximum of 10-fold under total population control. The release of chemosterilized males essentially eliminated the natural population from the island. Survival of adult females correlated with a rate of 25% mortality/day. A protozoan, Nosema, species, was highly infective and pathogenic to two species of anopheline mosquitoes and reduced adult longevity. Techniques of infecting mosquitoes were developed. Jackets of wide-mesh material treated with repellents showed promise for protection against biting insects. Several hundred compounds were evaluated as insect repellents, with 2 materials giving better results than standards in screening tests. A new type of CO(2)-mosquito trap proved more effective than standard traps using light, animal baits, or CO(2). Many repellent compounds were shown to cause 'space' as well as contact repellency. Studies on aerial applications of insecticides for mosquito control showed increased effective swath widths and lowered dosages for control. Electron microscope studies have shown structure, size, and tissue specificity of several protozoan and viral pathogens of mosquitoes.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0034, GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS

J.B. KITZMILLER, Univ. of Illinois, School of Liberal Arts, *Urbana, Illinois* 61801

Increasing resistance of insects to insecticides necessitates the search for other means of control. Among biological control mechanisms, genetic control offers several possibilities for ancillary reduction of the numbers of vectors.

The use of translocation stocks has been successfully demonstrated, in Culex,(Laven) to reduce and eventually eliminate, laboratory populations. A similar approach will be employed in 'Anopheles.'

Adult male of 'Anopheles albimanus' will be irradiated at dosages varying from 1,000 to 8,000 r to determine dose-mortality curves and optimal dosage for causing translocations. Based on prior experience, this will probably be near 4,000 r. At the selected dosage 2-3 day old males will be irradiated, crossed to normal females, and their progenies screened for translocations. This screening may be accomplished by 1) observation of semisterility in progenies, 2) mitotic and meiotic chromosome preparations, 3) salivary gland chromosome preparations. Translocation stocks involving the Y chromosome will always be heterozygous, and the translocation will be transmitted by males only. Several stocks will be maintained, differing in degrees of semisterility. Once stocks have been established, a laboratory cage experiment will be run, mating T females, in excess, with normal females. Each generation will be artificially structured to correspond with the theoretical reduction of the population. Theoretically, the introduction of semisterility in each generation will eventually result in the elimination of the cage population. If the cage experiment is successful, we shall try to arrange for an experiment to be set up on a small Caribbean island on which 'Anopheles albimanus' occurs, to see if eradication is possible in a natural situation.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

2.0035, VIRAL PATHOGENS

J.D. PASCHKE, Purdue University, School of Agriculture, *Lafayette, Indiana* 47907

The proposed studies will develop the necessary fundamental background for the use of the pathogenic mosquito iridescent viruses (MIV) for the biological control of mosquitoes. Comparative studies will be conducted on the serological, morphological, and physico- chemical properties as well as cytopathology of 'strains' of MIV. Comparative analyses will be made from in vivo and in vitro systems. The feasibility of virus propagation in vitro as a potential source of the pathogen for use in the biological control of mosquitoes will be determined.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

2.0036, RADIATION CYTOGENETICS OF THE YELLOW-FEVER MOSQUITO, AEDES AEGYPTI

K.S. RAI, Univ. of Notre Dame, Radiation Laboratory, *Notre Dame, Indiana* 46556 (AT(11-1)-38)

The major objectives of this research project have been (1) accumulation of basic cytogenetic information following irradiation and chemosterilant treatment in the yellow-fever mosquito, 'Aedes aegypti', and (2) possible application of knowledge thus gained for genetic control purposes. Areas currently active include cytogenetic analysis of radiation-induced translocations, cellular and chromosomal basis of mutagen-induced sexual sterility and manipulation of chromosomal mechanisms for mosquito control. There are several cytogenetic mechanisms, particularly those associated with structural chromosomal heterozygosity (reciprocal translocations, inversions, etc.), that may result in varying degrees of sterility.

Genetic analysis on two translocations has been completed. One RT (1:2) involes linkage groups I and II with the original break points 0.3 cross over units from sex on group I and 1.6 units from 'spot' abdomen gene on group II. The other translocation, RT (1:3) involves linkage groups I and III with the original break points 1.0 cross over units from red on group I and 0.5 units from the 'black tarsus' gene on group III. Population dynamics to investigate (a) the use of double translocation male heterozygotes (b) alternating releases of RT 1:2 and RT 1:3 heterozygotes and (c) release of individual translocations (one at a time) will be undertaken. In addtion, a search for translocation homozygotes and inversions will continue.

Part 1 of 2

SUPPORTED BY U.S. Atomic Energy Commission

2.0037, FACTORS AFFECTING ROLE OF MICROORGANISMS IN BIOLOGICAL CONTROL OF INSECT PESTS

E.S. RAUN, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01562)

OBJECTIVE: An understanding of the role pathogens play in insect populations. Clarify apparent changes in European corn borer susceptibility to strains of the pathogen, Perezia pyraustae (Protozoa).

APPROACH: Pyraustae occurs differentially in nature, appearing to respond in intensity to unidentified extrinsic factors. Strains of the host will be tested for susceptibility to selected strains of the pathogen over the range of environmental conditions encountered in the hosts range.

PROGRESS: The prevalence of microsporidian infections in a number of species of mosquitoes in central Iowa has been assessed. Voluminous data have been collected in an attempt to relate occurrence and intensity of infection to environmental factors such as oxygen, carbon dioxide, pH, temperature, nitrites, etc. This data is currently being readied for statistical analysis.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0038, POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES

G. FRIZZI, Istituto Genetico, *Cagliari, Italy*

The radiogenetic studies are proceeding according to programme, with the research into mutations, be they of theoretic interest - in order to mark the chromosomes or from the practical point of view, in order to find mutations, which will be of use for the biological control of Anopheles, as suggest by W.H.O. The surprising thing is that up to the present moment we have been able to obtain many chromosomal rearrangements, mostly inversions, translocations, but no genic mutations whatsoever.

After having studied genetically, biochemically, the only spontaneous mutant red eye- we are proceeding with a new line of research by means of autoradiography and with the electronic microscope. With the former process we are trying to follow the synthesis of DNA in the polytenic chromosomes, specially with regard to the heterochromosomes which we suspect play a most important role in the evolution of the sibling species. By means of the latter process we are trying to resolve the problem of the asinapsi which are to be found in the hybrids, of various crossing between the species. For what is concerned with our studies of biochemical genetics in mosquitoes we are at present studying new gene-enzyme system (alkaline phosphatases, esterases, xantine oxidases, malate dehydrogenases) in the attempt to put in evidence the existence of linkage group in at least one species by using these markers. In the cytogenetic field we still use the method of Guinacrine mustard, to show up by means of fluorescence - the zones of major concentration of Guanina in the mitotic chromosomes in order to see whether it is possible to distinguish the various species by means of this reaction.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

2.0039, RELATION OF APPLICATION METHODS, CONCENTRATION, AND VOLUME OF INSECTICIDE TO CATTLE INSECT CONTROL

F.W. KNAPP, Univ. of Kentucky, Agricultural Experiment Sta., *Lexington, Kentucky* 40506 (KY00476)

OBJECTIVE: Determine the rapidity of effectiveness and degradation of residual action on livestock insect pests insecticide formulations; determine intervals and methods of application, determine effect of environmental conditions on insecticidal treatment on animals.

APPROACH: Insects will be exposed to treated animals for 8 to 12 hours, and the dead and live insects counted. Blood cholinesterase determinations to determine toxic effect on host animal. Various application methods of insecticides will be used.

PROGRESS: Ultra low volume (ULV) aerial applications of naled, trichlorfon, Baygon and combination of fenthion and Baygon resulted in rapid knockdown of adult mosquitoes. Baygon applied in water and in combination with Fenthion showed no advantage over Baygon ULV alone. Trichlorfon shows great promise as it did control larvae as well as adults and has clearance for use in livestock as well as other crops. A new insecticide application method (SiCl(4) insecticide) (NH(3) H(2)O) -- (SiO(2)(s) insecticide) (NH(4)Cl(s) insecticide) that may be useful for fly and other insect control was found to be successful against mosquitoes. Low volume of insecticidal dusts, applied to cattle by self dusters, proved effective against the horn fly and reduced face fly populations. This method gives the farmer a practical as well as an economical fly control program.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0040, BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD

E.C. BURNS, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB00905)

OBJECTIVE: Obtain information on the biology, ecology and distribution of pests of livestock, poultry and pets. Evaluate the damage to livestock and poultry caused by insects, ticks, and mites. Develop and maintain effective and economical control measures.

APPROACH: Efforts to develop a technique for rearing horse flies under laboratory conditions for toxicological and biological studies will continue. Cages sufficiently large to simulate tabanid breeding environments will be utilized. Various types of traps, trap animals and larval collections will be used in seasonal abundance, geographic distribution, biological and ecological studies. Statewide surveys will be conducted to determine species and seasonal distribution of ticks in Louisiana. This study also will include evaluation of the fire ant as a predator of ticks. A program to determine any change in the effectiveness of existing recommended materials must be maintained and new candidate materials must be evaluated continually.

PROGRESS: No significant difference was found in rate of gain of beef cattle on which horn flies were kept to a minimum. However, populations of flies on the controls were low. Consistently good horn fly control was obtained with insecticides applied by dust bags when cattle were forced to use them. Results were erratic when the dust bags were offered free choice. Techniques have been developed for laboratory rearing of lone star ticks and for confining the ticks on large animals. Horse flies - Malathion treated, CO(2) baited traps did not provide effective control under field conditions; flowmeter tests on relationship of release rates of CO(2) to attractancy to adults were inconclusive; a general correlation existed between the incidence of anaplasmosis in a dairy herd and one tabanid species, carbohydrate source studies are incomplete; correlation studies between adult populations and certain meterological conditions are in progress. The feeding of natural populations of Psorophora confinnis caused economically significant reductions in average daily gain (0.4 lb/day) of feed lot steers receiving low energy rations (60% rice straw) compared to steers on the same ration protected from mosquito feeding by wire screen.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0041, CYTOPLASMIC INHERITANCE AND CONTROL OF CULEX PIPIENS

W.L. FRENCH, Louisiana State University, School of Arts, *Baton Rouge, Louisiana* 70803

The study of the cytoplasmic incompatibility system in Culex pipiens will provide basic scientific information concerning the nature and the segregation of cytoplasmic genes. Cytoplasmic incompatibility is the only system in which such a study is possible in any advanced form of animal life. The cytoplasmic system will be studied at the genetic and molecular level.

Strains of Culex mosquitoes will be developed by selective procedures for cytoplasmic genes. These mosquitoes will have a completely stable cytoplasmic mating type and will be ideally suited for use in the cytoplasmic incompatibility system for mosquito control.

The possibility that a second type of cytoplasmic sterility exists in Culex populations will be examined. This system may be useful as an alternative to the cytoplasmic mating type in mosquito control procedures.

A new procedure for the genetic control of mosquito populations will be developed. This is a genetic system in which the mosquitoes breed themselves to annihilation.

The mosquitoes developed for this control procedure would be of great scientific usefulness in studies of basic genetics and mutagenesis.

The tools of molecular genetic analysis will be applied to the problems of cytoplasmic inheritance genetics, molecular taxonomy and mosquito control.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

2.0042, BIOLOGY AND ECOLOGY OF SALT-MARSH MOSQUITOES OF LOUISIANA

E.S. HATHAWAY, Univ. of Southwestern La., School of Agriculture, *Lafayette, Louisiana* 70501 (00ENTH01121911CO)

OBJECTIVE: Determine population dynamics of salt-marsh mosquitoes of Louisiana and evaluate land and water management practices for control.

APPROACH: Conduct mosquito surveys to determine species, abundance, and migration. Determine effects on mosquito breeding by current and experimental water management procedures.

PROGRESS: Light trap studies indicated that the ratio of females to males for total catches was about 14 to 1. Anopheles crucians and Culex salinarius were collected the year around with the latter being the most abundant.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0043, BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST

H.C. CHAPMAN, Mcneese State College, U.S.D.A. Entomology Res. Div., *Lake Charles, Louisiana* 70601 (00ENTH0102190700)

OBJECTIVE: Determine distribution, abundance, taxonomy and ecology of mosquitoes, their biological control and effect of water-land management practices on their breeding in the U.S. Gulf Coast region.

APPROACH: Study oviposition preferences, ecological limitations, identify, culture and test pathogens and other biological control agents and determine their usefulness for controlling salt-marsh and rice field mosquitoes, sand flies, and gnats.

2. AQUATIC PEST CONTROL

PROGRESS: Salinity range had little effect on habitat selection by Orthopodomyia signifera whereas ovipositing females of Aedes triseriatus preferred low salinity habitats. Uranotaenia lowii was colonized for the first time. Although more than 46,000 adult females from our Thelophania infected colony of Culex salinarius were released over 32 weeks in the field, the level of infection, as assayed by egg raft collections, was no more than normal. Approximately 56% of the anopheline larvae in 48 weekly collections from a pond were infected with Coelomomyces. A new non-inclusion iridescent virus (COIV) was found in larvae of Corethrella brakeleyi. Chilo Iridescent Virus (CIV) is the first virus of non-mosquito origin (a moth) transmitted to mosquitoes. Nuclear polyhedrosis virus (NPV) in Aedes sollicitans infected 5 colonized mosquito species in the laboratory. Both NPV and CPV in A. sollicitans have been transmitted by adult females via the egg to their larval progeny. The level of Romanomermis infection in mosquito larvae varied with water level fluctuation of ponds and with temperature. Pressuring late 4th instars of Culex p. quinquefasciatus with large numbers of Romanomermis preparasitics resulted in the nematode being carried into adult mosquitoes. About 9.5% of the dissected adult females of A. sollicitans from the field were infected with the nematode Agamomermis culicis. Cultures of Romanomermis sp., Gastromermis sp., and Coelomomyces punctatus were established in artificial ponds in outdoor screened cages.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0044, BIOLOGY AND WATER MANAGEMENT STUDIES FOR CONTROL OF LOUISIANA MOSQUITOES (RICE FIELDS)

E.S. HATHAWAY, Mcneese State College, Graduate School, *Lake Charles, Louisiana* 70601 (00ENTHO1131907CO)

OBJECTIVE: Obtain biological data on seasonal variation of economically important mosquitoes common to rice fields and evaluate water management practices for their control.

APPROACH: Use light traps to survey the abundance of major species of mosquitoes in relationship to larval breeding areas in the rice fields and coastal marsh lands of Louisiana and evaluate water management practices as control measures for larvae.

PROGRESS: Research has continued at McNeese State College. Light trap studies indicated that the ratio of females to males for total catches was about 14 to 1. Anopheles crucians and Culex salinarius were collected the year around with the latter being the most abundant.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0045, EFFECT OF PREDATORS AND PARASITES ON MOSQUITO BREEDING IN LOUISIANA

E.S. HATHAWAY, Mcneese State College, Graduate School, *Lake Charles, Louisiana* 70601 (00ENTH01141907CO)

OBJECTIVE: Evaluate the potential of native fishes and insect predators for control of mosquito larvae in coastal-marsh areas of Louisiana.

APPROACH: Culture mosquitoes, native fishes, and insect predators in laboratory and field aquaria to determine biological control potentials. Evaluate the predators in semi-field tests.

PROGRESS: Predation studies in tanks were restricted to Gambusia affinis and demonstrated that on the average, as the minnows increased in size their consumption of mosquito larvae increased. Fish weighing .083 g and .425 g averaged 11 and 80 larvae, respectively. Larval consumption also varied by time of year (probably temperature related) from an average of 84/day in July and August to 6/day in December. Data on consumption rate of fish held individually, as compared to groups, was inconclusive.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0046, CONTROL OF BLACK FLIES AND MOSQUITOES IN MAINE

I.V. MCDANIEL, Univ. of Maine, Agricultural Experiment Sta., *Orono, Maine* 04473 (ME00193)

OBJECTIVE: Determine bionomics of the more important species of black flies and mosquitoes of Maine. Conduct research on practical methods of control. Conduct research on colonization in the laboratory.

APPROACH: Importance will be determined by an evaluation program in the field. Chemical and permanent control methods will be utilized. Rearing will be conducted in the laboratory in order to improve rearing techniques and evaluate factors that influence mating.

PROGRESS: Eggs of univoltine Aedes have been held for two years in viable condition. Some eggs hatched after three years of storage but the percentage was low. Selective breeding suggests that the ability of Aedes eggs to respond to a hatching stimulus is in part under genetic control. It is possible to select strains that will respond to either high or low oxygen levels. Work is being continued on a new technique for rearing black flies. The method has enabled us to rear rather large numbers of larvae under crowded conditions with low mortality in most cases. The method is unique in that larvae are put in motion rather than the water. Our mosquito collection is being worked up for a paper on species distribution and importance. The findng of A. pionips represents a new distribution record. We may have found a new species, but additional specimens are needed for confirmation. Simulium nyssa represents a new record for this area. A species of planarian, Phagocata woodworthi, has been observed to feed on black fly larvae. Mesostoma macroprostatum, a turbellerian, has been observed feeding upon mosquito larvae. Taxonomic problems relating to A. stimulans, excrucians and fitchii have been resolved and our specimens will be placed with the U.S. National Museum. We have developed a technique for obtaining mosquito eggs from the field in quantity for laboratory use. Most eggs can be readily identified by skilled workers. Eggs of A. Communis, abserratus and punctor, however, are easily confused and present problems which we have not been able to resolve.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0047, INTERSPECIFIC COMPETITION AMONG MOSQUITOES

L.E. ROZEBOOM, Johns Hopkins University, School of Public Health, *Baltimore, Maryland* 21205

The principal research objective will be to follow the progress of the colonization of the island of Taiaro, in the Tuamotu group, by A. albopictus, which was released there in January, 1970.

A preliminary field observation of the possible impact of invading A. albopictus on the resident population of A. guamensis, in Guam, will be made with the cooperation of the Navy's entomological unit.

Laboratory studies include cross breeding experiments between members of the Aedes scutellaris group to determine genetic relationships, and between these and A. albopictus in a continuing search for genetic barriers.

We hope also to study the mechanisms involved in the suppression of A. polynesiensis by A. albopictus in the larval stage.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

2.0048, GENETIC STUDIES ON THE CONTROL OF ARBOVIRUS VECTORS

H.C. BARNETT, Univ. of Maryland, School of Medicine, *Baltimore, Maryland* 21201

These investigations are concerned principally with genetic studies of the Culex tritaeniorhynchus complex of mosquitoes, vectors of Japanese encephalitis, West Nile fever and Chikungunya fever viruses and of Aedes aegypti, vector of yellow fever and the dengue viruses. There are two major objectives: basic studies of the genetics of these mosquito species and discovery and development of genetic mechanisms which will permit the biological manipulation or control of mosquito population. It is proposed to initiate or continue studies on mutants, cytoplasmic incompatibilities and other reproductive isolating mechanisms, inversions, translocations, meiotic drive, lethal and deleterious genes and enzyme polymorphisms.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

2.0049, INSECT CHEMOSTERILANTS

A.B. BORKOVEC, U.S. Dept. of Agriculture, Entomology Research Division, *Beltsville*, *Maryland* 20705 (00ENTM0204210200)

OBJECTIVE: Develop synthetic organic, organometallic, and inorganic compounds that are specific chemosterilants of insects and can be used safely and effectively.

APPROACH: Synthesize or procure a wide variety of compounds to be screened as insect chemosterilants. Investigate the mode of action of effective chemosterilants, correlate their structure with activity, and obtain basic chemical data needed for their analysis, formulation, and application. Make or procure larger quantities of promising compounds for further research and development.

PROGRESS: In the study of the mode of action of hempa, the previously postulated methylol intermediate has been synthesized and found active as a male sterilant. A series of (1-aziridinyl)phosphine oxides and sulfides was synthesized; several members of this series show high activity and a practical potential as mosquito sterilants. The study of interactions of this type of alkylating agents with DNA indicates a degree of crosslinking that can be correlated with sterilizing activity. Nonalkylating dithiazolium derivatives were found to be equal to the best alkylating agents as male sterilants. Further synthesis and structure-activity studies are in progress. For the screening program, 201 new candidate chemosterilants were submitted. Larger quantities of tepa, thiotepa, and ENT-50838 were prepared for field experiments conducted by the Division.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0050, BIOLOGICAL EVALUATION OF INSECT CONTROL AGENTS

R.L. WALKER, U.S. Dept. of Agriculture, Entomology Research Division, *Beltsville*, *Maryland* 20705 (00ENTM0901210200)

OBJECTIVE: Initial evaluation of activity of new chemical materials and new formulations against insects.

APPROACH: Make small-scale laboratory tests on selected insect species of new synthetic compounds and natural products for activity as insecticides, synergists, chemosterilants, attractants, repellents, or hormone-type growth regulators. Study mode of action and metabolism of chemosterilant compounds and other new types of agents in insects. Evaluate new aerosol and space spray formulations against resistant and nonresistant houseflies and mosquitoes. Coordinate screening of new compounds at all Entomology Research Division laboratories. Investigate production and release of sex pheromones in insects.

PROGRESS: Three hundred seventy-six compounds from industry or Government sources were distributed from Beltsville to ENT laboratories for preliminary evaluation as insecticides or acaricides; 2 materials of natural origin and 678 synthetic compounds from ENT chemists, private industry, or other Government agencies were distributed for tests as insect attractants, repellents, or chemosterilants. Of 123 materials further evaluated in the field several were found to be effective against some major 'hard to control' pests such as the tobacco budworm, bollworm, and cabbage looper. Thirty-four materials equalled a fencholic acid standard in repelling one or more of four economic cockroach species. A new aerosol, G-1707 (pyrethrins 0.45%-Tropital synergist 2.7%) was developed and accepted for use on ships and aircraft by the USPHS in lieu of two previously used aerosols containing DDT. Of 45 materials of natural origin and 319 synthetic compounds evaluated for hormonal activity against two insect species, 40 showed good activity. The structure-activity relationships of bis-aziridinyl phosphorus compounds were elucidated in a critical evaluation of the male sterilizing potency of these compounds on the house fly.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0051, MALARIA ERADICATION RESEARCH

G. PEARCE, U.S. Dept. of Hlth. Ed. & Wel., P.H.S., *Bethesda*, *Maryland* 20014

Purpose: To maintain effectiveness and economy in malaria eradication programs through investigation and development of new or improved equipment, materials and methods.

Description of Activity: The project is located in the PHS Technical Development Laboratories, Savannah, Georgia. Investigations are chemical (insecticide formulation and testing), engineering (insecticide packaging and application equipment), and biological (mosquito control). Facilities include large colonies of major problem species of malaria mosquitoes, extensive laboratories and workshops, and a wide range of simulated representative housing conditions. Work is closely coordinated with related programs of WHO, PAHO, UNICEF and numerous countries.

Accomplishments: Contributions have included high quality formulations of DDT and other insecticides, improvement of insecticidal equipment and packaging with great savings thorough enhanced efficiency and prevention of waste, demonstration of effective insecticides to be used instead of DDT, and studies of materials and methods alternative to insecticidal control. The project has provided consultation and training assistance to numerous overseas programs.

Future Targets: As the worldwide malaria eradication program progresses, methods other than standard DDT house-spraying techniques are increasingly revealed as necessary for a successful conclusion of the program in special problem areas. An expansion of investigations toward effective alternative and supplementary methods is proposed during the next two years.

SUPPORTED BY U.S. Dept. of State

2.0052, BIOLOGICAL AND BIOCHEMICAL FACTORS INFLUENCING THE DEVELOPMENT OF LARVAL MOSQUITO POPULATIONS

T. M. PETERS, Univ. of Massachusetts, Agricultural Experiment Sta., *Amherst*, *Massachusetts* 01002 (MAS00253)

OBJECTIVE: Study ecology of mosquito larvae, including: comparative study of pond ecosystems. Comparative study of sampling.

APPROACH: Investigate natural populations, manipulate population ratios between carnivorous-herbivorous and herbivorous-herbivorous mosquito complexes. Modify biotic and physical environment by: Removal and addition of vegetation, Addition of non-toxic dyes to interfere with light penetration, Additon of commercial fertilizers to alter the microbiota. Test sampling techniques. Study mosquito movements by mark and release method, stratified sampling, and underwater observations.

PROGRESS: Methylene Blue, 0.5-2.5 ppm., and neutral red, 3-9 ppm., have been shown to retard growth as effectively as Nile Blue A, 0.25-2.5 ppm., demonstrating that growth retardation by vital dyes is not tied to a specific respiratory block. Growth retardation by exposure to vital dyes is not linked to starvation phenomena. Compensatory mechanisms available for survival of mosquito larvae under environmental stress are being investigated. Under increasingly crowded-starved conditions (treatments of 40, 160, 280, 400, 520, 640, 960, 1280 larvae/universe) reduction of biomass, 0.59 mg (40/universe) to 0.19 mg (1280 universe), is linked to prolonged mean developmental period, 123 hrs. (40/universe) to 624 hrs. (1280/universe), so that even with a final average of 70% mortality (1280/universe) compared with 13% mortality (40/universe) the most crowded population begins to 'pump out' undersized but mature individuals, rather than succumb to 'collective suicide' as previously suspected.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0053, FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS

D.L. HAYNES, Michigan State University, Agricultural Experiment Sta., *East Lansing*, *Michigan* 48823 (MICL00969)

OBJECTIVE: Identify bacterial, viral, protozoan, fungal and rickettsial parasites and nematodes of economically important insects. Establish the factors and their interrelationships that affect the abundance and distribution of these microorganisms in nature. Determine pathology of organisms referred to in Objective 1. Develop techniques for propagating and maintaining pathogens and their subsequent application to field populations of insects. Evaluate the effectiveness of selected insect pathogens in the field.

APPROACH: Search for indigenous nematodes and microorganisms capable of parasitizing Michigan Scolytus multistriatus populations; carry out laboratory studies on conditions favoring parasitization, multiplication and dissemination; Procure and cultivate exotic forms for possible dissemination and evaluation and analyze requirements of promising species in relation to the Michigan environment.

PROGRESS: Intraspecific competition for food in fields of high density is the major regulating factor in beetle survival. There are several regions in Michigan which are producing cereal leaf beetles at this maximum carrying capacity in addition to Berrien County. Population in Jackson, Shiawassee and Kalamazoo counties have densities equal to Berrien. Total defoliation to wheat occurred at the Gull Lake Biological Station in 1969 and it is expected that corn will sustain measurable damage to its foliage from feeding adults for the first time in this region. The parasitic mermithid nematode found attacking the snow mosquito in Michigan has been tentatively assigned to the genus Hydromermis as a new species by the Nematology Investigations Group of the United States Department of Agriculture. Basic studies of the life history of the parasite have been initiated. Infection has been shown to commence in the first instar mosquito larvae. Percent infection of immature mosquitoes sometimes reaches 85 percent. Encapsulation of the parasite by the host also begins in the first instar larvae. However, the percentage of hosts with encapsulated nematodes does not increase after the second instar. Parasites in early instar larvae are chiefly localized in the head: later they migrate to the abdomen of the host.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0054, BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS

E.F. COOK, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-17-017)

OBJECTIVE: Pursue anatomical and biological studies on the various taxa of aquatic arthropods and their relatives that will enable us to recognize, characterize, and rank them. Concurrent with the above objectives, it is intended to develop a knowledge of the aquatic arthropod fauna of Minnesota.

APPROACH: Biological and anatomical studies of aquatic arthropods of all types, food habits, ecological relationships, life histories, distribution, etc., will be pursued as the need arises in specific taxonomic areas. These studies will be adapted to problems as they develop and will combine both the anatomical and biological approach. Emphasis will be placed on work with living aquatic insects and aquatic insect populations but not to the exclusion of preserved museum specimens.

PROGRESS: Additional records have been added to the preliminary catalog of the aquatic insects of Minnesota. Revisional studies on several taxa of Chironomidae are still underway with the revision of Diamesinae nearing completion. A revision of the genus Optinervius in the Elmidae has been completed. The light trap collection of aquatic adults made in 1968 has been sorted and partly identified; sorting of material collected in 1969 is now underway.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0055, SUSCEPTIBILITY OF INSECTS TO INSECTICIDES

L.K. CUTKOMP, Univ. of Minnesota, Agricultural Experiment Sta., *Saint Paul, Minnesota* 55101 (MIN-17-048)

OBJECTIVE: Effectively use a poorly persistent insecticide as related to cyclical metabolism or behavior of the treatment insect. Studies of the magnitude of differences in cyclical physiological events as correlated with the magnitude of tolerance to rapid-acting insecticides. Relate insecticide pick-up to symptoms and mortality and metabolic or behavioral activity.

APPROACH: Measurements of oxygen consumption (as a measureable indicator or metabolism) over several consecutive 24-hour periods. Selected insecticides (organophosphates and carbamates) evaluated for effectiveness at different times. Correlations of time of effectiveness and time of cyclical events will be used as guides. Organisms to be tested are American cockroaches, larvae of mosquitoes (Aedes aegypti).

PROGRESS: A circadian (about once in 24 hours) rhythm of oxygen consumption has been shown for adult flour beetles, Tribolium confusum, and larvae of the yellow fever mosquito, Aedes aegypti. The peak periods (maximum uptake), called acrophase, were between 4 and 6 p.m. for mosquito larvae and 8-9 p.m. for flour beetles. Statistical treatment, involving methods of least squares and cosine analyses are yet to be applied to verify significance. Inspection of the data would, however, indicate a greater rhythm amplitude in mosquito larvae than in flour beetles. Experiments designed to correlate insecticide sensitivity with rhythm characteristics have not been significant, although further experiments are desirable. A study of the specific activity of the enzyme system, adenosine triphosphatase (ATPase) in whole mosquito larvae indicate maximum activity at about midnight, some 4 hours later than the time of maximum oxygen consumption.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0056, ABUNDANCE, DISTRIBUTION AND CONTROL OF MISCELLANEOUS INSECTS, AFFECTING LIVESTOCK

R.H. ROBERTS, Delta Branch Experiment Sta., *Stoneville, Mississippi* 38776 (MIS-SUT-007)

OBJECTIVE: To evaluate current and develop new information on the control of foul mites, ticks and lice under Mississippi conditions. Conduct tests on the control of ticks on cattle and mosquitoes as they may effect livestock.

APPROACH: Conduct tests on control of ticks of cattle and on mosquitoes as they affect livestock. A field trial insecticide program treating livestock, litter, farm buildings, dusting sites, and/or barrier strips.

PROGRESS: No progress reported this period (active project).

SUPPORTED BY Mississippi State Government

2.0057, BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK

C.W. WINGO, Univ. of Missouri, Agricultural Experiment Sta., *Columbia, Missouri* 65201 (MO00046)

OBJECTIVE: Study the factors contributing to occurrence, abundance and activity of arthropod pests of livestock. Relate these factors to control of pest species in order to prevent physical losses and debilitation and/or death by arthropod-borne disease organisms. Evaluate the use of chemical agents.

APPROACH: Studies involving the biology, especially ecological factors, affecting the pests of livestock will be done. Studies to formulate control methods for pests.

PROGRESS: A study of factors affecting mosquito control in and around small urban communities was completed. Results of the study show that the major portion of the control program is devoted to fogging operations which are often ineffective even as temporary measures because of unsuitable climatic conditions. Larviciding was of much greater benefit especially in the case of one of the two dominant species, Culex pipiens complex. Light trap and larval surveys indicated that the other species of most importance, Aedes vexans, did not breed extensively within the urban limits and for this species local larvicide programs were relatively ineffective. The laboratory face fly host- adapted strain of Aphaereta pallipes was carried through more than 25 generations in the laboratory. A peak of 90% parasitism occurred during the 13th generation. Maximum natural emergence from face fly puparia was 50% during the 18th generation. Alysia ridibunda (Say) has been confirmed as the species parasitizing bucoprophilous flies in Missouri. The principal host of A. ridibunda has been found to be Ravinia assidua (Walker). Four Malaise traps were operated in 4 sections of the state to collect horse flies as they occur seasonally. There records will be used in connection with biological studies of species dominant previous to and during anaplasmosis outbreaks.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0058, INSECT SURVEY OF MONTANA

E. HASTINGS, Montana State University, Agricultural Experiment Sta., *Bozeman, Montana* 59715 (MONB00405)

OBJECTIVE: Maintain and further develop research and working insect collection; investigate and make control recommendations on local infestations of various destructive insects; carry on research projects on problems which are limited in their scope, coordinate the work of mosquito abatement districts within the state.

APPROACH: This project is carried as a miscellaneous catch-all to provide a means to perform the odd jobs we are continuously called upon to do. In general, we may investigate insect problems which we feel are serious enough to warrant this activity, estimate their extent and seriousness, and try to advise on methods of alleviation.

PROGRESS: Preliminary investigations on face fly infestations in Montana were made under this project. In 1968, control by self- applicatory devices was tested extensively and found to be feasible, but in many cases grower-inertia tended to negate this approach. Two releases of Aleochara tristis (an introduced beetle parasite of face fly pupae) totalling 40,000 specimens were made in the Hamilton-Victor area in late 1967 and early 1968. To date, attempts to demonstrate their having established themselves successfully have proved unfruitful. Parasitism of face flies by the naturally occurring parasitic nematode, Heterotylenchus autumnalis ranged from 20 to 50 percent in 1968, which may have been a factor in the notable reduction of 1968 infestations. The reference collection of insects was maintained. Mosquito, alfalfa weevil, and grasshopper infestations were evaluated.

SUPPORTED BY Montana State Government - Helena

2.0059, SURVEY OF INSECT PROBLEMS IN MONTANA

E. HASTINGS, Montana State University, Agricultural Experiment Sta., *Bozeman, Montana* 59715 (MONB00407)

OBJECTIVE: Provide identification of insect species; develop and maintain reference and research collection of insects. Evaluate damage potential of sporadic insect infestations and, if necessary, initiate short-term control studies. Assemble material for State Entomologist Biennial Report. Furnish information to mosquito abatement districts.

APPROACH: Carry forth procedures necessary to accomplish above objectives using standard and experimental entomological procedures.

PROGRESS: Associated with a project entitled 'The Ecological Effects of Weather Modification', insects were collected from the Bangtail study areas in an attempt to ultimately relate insect population changes with vegetative changes. These collections are currently being processed. Recent collections have been limited to grasshoppers alone, and in part because of very limited numbers, few, if any, valid correlations may be expected. The widespread occurrence of army cutworm and army worm populations of variable density throughout cultivated areas of Montana resulted in much concern and numerous requests for evaluation of damage potential. Heavy stream flow along with timely rains contributed to a relatively severe mosquito problem occurring in many sections of the state. Six of the present seven mosquito control districts were visited, their problems evaluated in some cases and local boards and control personnel conferred with regarding their problems of source reduction and insecticide application, a very touchy subject in and around urban areas.

SUPPORTED BY Montana State Government - Helena

2.0060, MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT

L.E. HAGMANN, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00402)

OBJECTIVE: Investigations on basic mosquito biology control by biological, chemical, and physical measures.

APPROACH: Biological - species distribution surveys, feeding habits and host preferences, diapause in aedine eggs and hatching stimuli, colonization of native aedine species and larval and adult parasites. Chemical - screening candidate insecticides, resistance to DDT, studying properties of oil carriers, and field tests. Physical - water management procedures, water quality related to mosquito production.

PROGRESS: Statewide larval surveys continued. Heavy populations of early spring floodwater Aedes were noted. Summer rains caused flooding and heavy populations of Aedes vexans and A. trivittatus. Culiseta melanura populations on the increase. This was reflected in the heavy resting box catches. A. vexans completely refractory to colonization in the laboratory, while A. sollicitans has shown some response. Circadian rhythms of both species are being studied. Colonies of 4 species are currently being maintained. Host preference studies continue. Filaria parasite of bullfrog now maintained in the laboratory. Studies on mosquito pathology continued. Resistance tests on field populations of both larvae and adults monitored. Base lines for Abate and Baytex established. No DDT resistance in aedine populations. Of newer materials tested only Dursban appears effective. Work on non-target marsh organisms continued. Cooperative studies on coastal wetlands involving other state agencies continued.

SUPPORTED BY New Jersey State Government - Trenton

2.0061, COORDINATION OF MOSQUITO CONTROL IN NEW JERSEY

D.M. JOBBINS, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00401)

OBJECTIVE: The coordination of mosquito control including review and approval of county commission plans and budgets. Statewide surveillance of mosquito problems. Service to county commissions. Technical and administrative aid to the State Mosquito Control Commission. The dissemination of information on mosquitoes.

APPROACH: Coordination activities with all groups concerned with wetlands and the management of mosquito-producing waters. Statutory and assigned obligations will be discharged. Statewide mosquito surveillance through ground inspection and mechanical traps will continue.

PROGRESS: Mosquito control County programs budgeted in excess of $5,000,000 were reviewed. State-aid grants budgeted at $375,000 for basic mosquito control and $150,000 for aircraft insecticidal application were allocated or administered. Objectives of valuable plant, animal and marine resources; to further regional projects in water management in upland forest and estuarine zones; and to concentrate mosquito control on areas of recent and potential involvement with eastern encephalitis. Mosquito surveillance continued throughout the state, in indicator areas and those recently subjected to flood damage and encephalitis outbreaks. No mosquito transmitted encephalitis in man was reported in 1969. In administering the augmented aircraft spray program in 7 counties for the 20th season improved techniques in application of ultra-low volume malathion and other non-persistent formulations were investigated. New amphibious excavator equipment advanced hydraulic alteration of tidal marshes in the Delaware Bay and Atlantic regions. Public education continued through meetings, short courses, conventional publicity and publication of the Proceedings of the New Jersey Mosquito Extermination Association.

SUPPORTED BY New Jersey State Government - Trenton

2.0062, MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE

D.M. JOBBINS, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00426)

OBJECTIVE: Evaluation of mosquitoes on production of meat, milk and animal products and development of procedures for reducing economic loss. Definition of mosquitoes in management of equines and research on systemic and surface repellents for animals. Role of mosquitoes in transmission of virus and protozoan diseases of domestic birds and animals and reservoirs of diseases.

APPROACH: Comparative sampling of mosquitoes by trapping, resting shelters and visual observations on domestic animals. Serological determinations of mosquito blood-meals; collection of sera, antigen preparation and parasitological study.

PROGRESS: Serological identification of mosquito blood meal sources continued as a basic research study of host preferences and as a State Health Department shared project toward defining the reservoir hosts and vectors of viral encephalitis. Virus isolation by SHD follows host identification. Colonization of Culex teritans was established as was Toxorhynchites rutilus. Both have significant research potential. Frog filariasis is being developed as a laboratory model for mosquito-borne filariasis. The bullfrog filaria involved is a new species being described. A New Jersey Blackfly survey is in progress as preliminary to biological control research, 16 species were revealed in some 150 different sites. New Jersey mosquito species are being completely reexamined from taxonomic and biological relationships. Extensive reference collections were mounted. Search for virus vector associations in nature continued. Among biological assay agents Cyclops vernalis was used to evaluate effects of Abate, malathion, Flit-MLO, Paris Green and other mosquito larvicides. Refinements in assay technique using algae and food culture components show promise. Cyclops spartinus was the field assay agent.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0063, MOSQUITO CONTROL - TIDAL MARSHES

F. FERRIGNO, State Div. of Fi. Gm. & Shfsh., *Trenton, New Jersey* 08625

Objectives: Chemical and physical evaluation to provide adequate control of mosquitoes on tidal marshes. Also, to evaluate their effects on other marsh organisms as well as the water, soil, and other interests.

Procedures: Over the years this study has supplied us with much information on the problems associated with coastal mosquito - wildlife management interests. Studies to be undertaken pertaining to transporting and building up of residual insecticides on marshes or within marsh organisms. Accordingly, it is urgent that an organization equipped with facilities to determine the chemical analyses of water, soil, salt bay eggs, micro and macro-organisms, and tissues, cooperate in the study. Every effort should be made this year to determine the 'hidden effects' of these chemicals in this environment. In addition, experimentation will continue on open marsh water management in an effort to provide long-lasting control of mosquitoes and a better environment for fish and other wildlife. Ponding and ditching will be evaluated.

This study will eventually lead to control of pestifereous insects, improvement of the tidal food web, and eventually elimination of insecticide from tidal marshes. Over 2000 acres of heavy mosquito breeding marshes have been controlled by open marsh water management.

Chemicals are no longer needed on these areas and organisms of the food web are increasing.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0064, WATER MANAGEMENT IN MOSQUITO IMPOUNDMENTS

F. FERRIGNO, State Div. of Fi. Gm. & Shfsh., *Trenton, New Jersey* 08625

Objectives: To carry on investigations on the effects of diking, pumping, and lowering the water table in impoundments managed for mosquito control.

Procedure: There are many problems that will have to be studied in this environment such as population, fresh water reserves, salt water intrusion, mosquito production and wildlife use. After evaluating the effects of present management, recommendations will be made to satisfy a multiple of interests.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0065, MOSQUITO CONTROL IN UPLAND SWAMPS

F. FERRIGNO, State Div. of Fi. Gm. & Shfsh., *Trenton, New Jersey* 08625

Objectives: To determine the effects of mosquito control practices (water management or insecticide applications) on the upland fauna.

Procedure: After an upland swamp has been treated with an insecticide or ditched, larval dippings, cover-typing, collection of pesticide samples, and wildlife population and utilization counts will be made and compared with an untreated swamp.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0066, CONTROLLING MOSQUITOES ON HAYING MEADOWS

F. FERRIGNO. State Div. of Fi. Gm. & Shfsh., *Trenton, New Jersey* 08625

Objectives: To evaluate chemical and/or physical control of mosquitoes on diked salt hay meadows from the standpoint of its effect on vegetation, water, soil and marsh organisms.

Procedures: Mosquito control treatments on haying marshes will be evaluated by making mosquito larval dippings, plankton samples, soil analysis, cover-typing, wildlife population and utilization censuses, and bag checks.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0067, STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS

B.V. TRAVIS, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00153)

OBJECTIVE: To renew studies of biting flies and related insects to arrive at more acceptable means of control.

APPROACH: Biting flies along with certain related, but non-biting species, limit or prohibit outdoor activities in New York during the warmer portions of the year. Limitations in the use of insecticides because of a potential for pollution make it necessary to renew the studies of such insects in order to arrive at more acceptible means of control. Populations of such insects seem to be increasing because of man-induced changes in the environment. Surveys of the occurrence of species, studies of their biology and behavior, and investigations of control tecnhiques both biological and chemical are proposed, with emphasis placed upon black flies and mosquitos.

PROGRESS: Stored products insects: The production of quinones by several stored products insects, especially Latheticus oryzae and Oryzaephilus surinamensis, was examined. The presence of these substances, both natural and artificial, was studied with respect to effect upon fecundity. p-Benzoquinones in media maintained at 26 C and 65% relative humidity were found to reduce fecundity. Failure of an incubator and the resulting loss of colonies of insects caused a considerable delay in the work. Mosquitoes: A study of the factors affecting egg production of Aedes triseriatus has been completed. The major findings were: the number of eggs matured by mated mosquitoes is correlated with body weight, blood meal weight, and fed body weight; blood meal size is almost twice as effective in predicting egg number as is body size; mated mosquitoes produce a greater number of eggs than do virgins; as the size of the mosquito increases, the minimal quantity of blood required for egg maturation also increases; mated and virgin mosquitoes do not differ in the intensity of their biting drives or in their oviposition times following the blood meal; unmated mosquitoes retain matured eggs with a greater frequency and have a greater mortality rate than do mated mosquitoes. Black Flies: Screening of 22 new insecticides against black fly larvae were completed.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0068, INSECTS AFFECTING MAN

B.V. TRAVIS, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00641)

OBJECTIVE: Biting Insects: Learn which species are important; obtain the necessary biological information for effective control; make field trials for working out the best control measures. Household Insects: Learn the feeding responses, food relationships, biology and ecology of the household insects and apply these findings in a search for more effective means of control. New and old chemicals will be screened.

APPROACH: Biting Insects: Two lines of investigations will be followed: a survey and methods of control. Household Insects: Comparisons of duration of life-cycle, oviposition and larval feeding will be studied regarding feeding responses and food relationships. Insecticide residues on various treated surfaces and time intervals measured for relative toxicity and residual effectiveness.

PROGRESS: Cluster Flies: Possible control of cluster flies by treating the exterior of houses which are regularly infested was studied using 46 houses scattered about Tompkins County. Preliminary examination of data reveals wide variations in results, especially one week and more following treatment. Effectiveness of insecticidal treatments of the outside of houses is too short-lived to be of practical value. Mosquitoes: A survey of selected sites in Tompkins County has yielded 27 species identified from more than 3500 larvae and adults collected and preserved for the museum during the year. Seasonal distribution, ecological factors and the incidence of aquatic mites on larvae are being tabulated. Records and specimens from previous unpublished surveys are also being considered in the study. Black Flies: Sampling of black fly populations in Tompkins County, N.Y. commenced during June of 1968 and was completed during September of 1969. Most immature specimens have been identified and fifteen species have thus far been located from the immature collections. Identification of over 600 adult black fly specimens acquired during the survey field work is proceeding well. At present the data on the species and ecology are being assembled.

SUPPORTED BY New York State Government - Albany

2.0069, LEGAL REPRESENTATION OF CITIZEN'S INTERESTS IN ENVIRONMENTAL PROTECTION

UNKNOWN, Environmental Defense Fund, *Riverhead, New York*

The Environmental Defense Fund had its origin in a suit filed in April, 1966, by a citizen of Suffolk County, Long Island, who sought to enjoin the county's mosquito control commission from any further use of DDT. Even though the courts dismissed the suit on technical grounds, the testimony of scientists aroused such public interest that the County Board of Supervisors barred the use of DDT.

In 1966, the Long Island group, now augmented by additional scientists, incorporated and expanded their work nationwide. EDF went on to build its reputation in Michigan, Wisconsin, and Montana, with effective legal actions against the U.S.Department of Agriculture and the Army Corps of Engineers among others.

EDF brings cases in its own name as a representative of the citizen's interest in environmental protection. Like the other organizations, it also brings legal action on behalf of long-established conservation groups (the National Audubon Society and the Sierra Club, for example). The Foundation grant will enable the organization, which up till now has relied on small grants and contributions plus membership fees, to expand its scientific and legal work.

SUPPORTED BY Ford Foundation - New York, N.Y.

2.0070, MODE OF ACTION OF A NEW FUNGAL PATHOGEN OF MOSQUITOES

D.W. ROBERTS, B. Thompson Inst. Plant Res., *Yonkers, New York* 10701

Studies on the pathogenicity of Metarrhizium anisopliae have shown that it is capable of causing a fatal disease of all species of mosquito tested to date. It may destroy the larvae by localized mycelial invasion or apparently by production of toxins after ingestion of ungerminated spores. The possibility of exploiting this pathogenicity for mosquito larvae is more promising than for most of the terrestrial host species where conditions of low humidity often restrict the pathogen's development.

Careful studies are needed on the methods of disease induction. Particular attention will be paid to the production of mycotoxins. Also mitotic recombination will be sought as a possible mechanism for producing strains of the fungus with selected desirable characteristics for microbial control or elucidation of modes of disease induction. Outdoor tests will be conducted to determine if the high mortalities commonly attained in the laboratory are also possible in the field. In addition, compounds toxic to mosquito larvae will be sought in cultures of another entomogenous fungus, Beauveria bassiana.

The basic data obtained should prove valuable in determining whether the pathogen may be used in a practical way to suppress mosquito populations or to reveal highly specific exotoxins that could be useful in controlling mosquitoes of economic importance.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

2.0071, POTENTIAL OF COELOMOMYCES FOR CONTROLLING MOSQUITOES

D.W. ROBERTS, B. Thompson Inst. Plant Res., *Yonkers, New York* 10701

Fungi of the genus 'Coelomomyces' are worldwide in distribution and cause high mortalities in mosquito populations. They are not likely to cause environmental pollution since they are host specific for mosquitoes and do not grow saprobically. Nevertheless, the potential of these fungi has not been realized because no one has successfully cultured them in vitro or precisely determined the conditions under which they attack mosquito larvae most effectively. There is ample evidence, however, that they can be established in new localities where they persist and cause disease from year to year. Several field collected species will be examined for their adaptability to laboratory study; but 'C. psorophorae', a species with wide host range (4 mosquito genera) and distribution (much of the U.S.) and which is easily germinated in the laboratory, will be emphasized in initial studies. We propose to determine with the one species the ecological parameters necessary for disease induction, to describe the details of infection and disease development, to culture the fungus in vitro, and in addition to survey locally for the first time for the occurrence of 'Coelomomyces' in field populations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

2.0072, STUDIES ON SOME FUNGAL PARASITES OF MOSQUITOES

J.N. COUCH, Univ. of North Carolina, School of Arts, *Chapel Hill, North Carolina* 27514

With improved methods for carrying on the infection experiments in the greenhouse with Coelomomyces punctatus in Anopheles quadrimaculatus I can regulate the amount of kill up to near 100%. Studies to find better ways to store and transport the inoculum, to find out how the fungus enters the coelom and the more precise pathologic effects of the fungus on the host are in progress or being planned. I plan to continue the field tests with Coelomomyces punctatus in An. quadrimaculatus; to find out if resistant races of Anopheles quadrimaculatus occur in nature or develop in our infection experiments. Our search for Coelomomyces sp. in the malarial mosquitoes in Panama which has been in progress since last January 1970 will be continued. This work is in cooperation with the Gorgas memorial laboratory in the Canal Zone. Dr. Iyengar in Bangalore, India is continuing to send me Coelomomyces material from India for infection as well as taxonomic studies.

Work is in progress on a taxonomic monograph describing all known species.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

2.0073, EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE 1

E.J. KUENZLER, Univ. of North Carolina, School of Public Health, *Chapel Hill, North Carolina* 27514

The proposed study would be conducted in ditched and unditched Juncus marshes near Beaufort and Willison, North Carolina. The project would begin July 1, 1970 and would extend through June 30, 1972.

There are involved three ecological systems to be considered. 1) the unditched Juncus marsh, represented in the study by the control marsh; 2) the ditched Juncus marsh; and 3) the new aquatic systems in the ditches. The project may be divided into a series of problems and methods as follows: 1. Does the ditching provide a significant addition to the total subtidal area in an estuary? Methods - The area of the ditches will be measured and compared with the area of the estuary. 2. What kinds of ecosystem occupies the ditches? Are the ditches used by significant quantities of commercially valuable species, especially shrimp? Methods - Sampling for commercially important forms will be conducted at regular intervals. 3. During periods of inundation, does any significant flux of nutrients occur between Juncus marsh and the nearby estuary? If there is a detectable flux, is it measurably affected by ditching? Are the direction and rate of exchange dependent upon the concentration of the nutrient in the water when it covers the marsh? Methods - Nutrient flux will be evaluated in natural and experimental systems. 4. Could the mosquito control ditches be used for aquaculture? Methods - The potential of the ditches for oyster culture will be evaluated by measuring the growth rates of oysters placed in the ditches. 5. Is the ditching causing any significant change in plant community structure? Methods - A survey of plant distribution and biomass per unit area in ditched and unditched marshes will be conducted every two months.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0074, THE CONTROL OF MOSQUITOES OF MILITARY IMPORTANCE AND THE PREVENTION OF MOSQUITO-BORNE DISEASES

R.H. GROTHAUS, U.S. Navy, Medical Field Res. Lab., *Jacksonville, North Carolina* 28542

Technical Objective: Study the composition and biology of the complex mosquito population in the camp Lejeune. N.C. area and apply this information to the development of effective and economical control techniques for the protection of troops from the annoyance and potential disease related to the biting habits of these species.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0075, EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA

K.L. KNIGHT, Univ. of North Carolina, School of Agriculture, *Raleigh, North Carolina* 27607

'Juncus' or black needle rush marshes in the coastal zone of North Carolina constitute major breeding areas for salt marsh 'Aedes' mosquitoes. These mosquitoes are sufficiently abundant to seriously interfere with the development of coastal lands. Control of this mosquito production is being attempted by ditching. This project is designed to evaluate the effects of 'Juncus' marsh ditching upon the production of mosquitoes. In accomplishing this task the total ecology will be considered, in that it will be done cooperatively with ecologists who will be interested in the comparative release of energy from ditched and unditched 'Juncus' marshes into estuarine waters. The mosquito studies will also involve an attempt to determine and quantify environmental factors that might serve to modify the effects of ditching upon mosquito population numbers.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0076, EMERGENCY INSECT CONTROL

J.T. SCHULZ, North Dakota State University, Agricultural Experiment Sta., *Fargo, North Dakota* 58103 (ND-S-05-001)

OBJECTIVE: Investigations on insects not covered by regular station or federal research projects. Investigations of a temporary or sporadic nature.

APPROACH: Initiate new investigations to provide basis for writing more formal outlines. Investigate and issue recommendations for control of insect problems that occur sporadically or are of local importance.

PROGRESS: Marked reduction in populations of most species of sunflower insect complex recorded; especially true for moth, Homeosoma electellum, less for Phalonia hospes. Exception was maggot (Tephritidae) complex; nearly 100% infestation of heads and stalks was recorded. No varietal differences observed. Principal species were Strauzia longipennis and Neotephritis finalis. Biology and ecology of maggot complex under study. Experimentation with artificial and synthetic diets for rearing Strauzia, Homeosoma and Phalonia in progress. B. thuringiensis-Granular formulation applied against European corn borer gave promising results at 20lb/A. Liquid formulation applied to gooseberry against Forest tent caterpillar gave good control at 2 qts./A. (R. D. Frye). Barley thrips showed no preference in variety plots; infestations too light to assay damage. Mosquitos-Count of dead insect predators following citywide aerial spraying showed many dead lacewings, coccinellids, and syrphids. Grain, straw and soil samples now being processed for preplant soil treatments of chlordane spray 0 4,6,10 lb a/A for barley, oats, rye, wheat; seed treatments of liquid tech. and WP Baygon 37289 on wheat and foliar methyl parathion on rye. Wheat stem sawfly-Under controlled laboratory conditions when fed on artificial diet photoperiod and temperature influence diapause and development.(JAC)

SUPPORTED BY North Dakota State Government

2.0077, NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS

R.L. GOULDING, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00515)

OBJECTIVE: Research new approaches to the use of pesticides for control of arthropod pests or parasites. Current emphasis to be on pesticide-polymer resin formulations. Evaluate existing or experimental procedures or products for efficacy and host toxicity.

APPROACH: Develop basic concepts of retention and desorption kinetics of existing pesticide-polymer formulations. Utilize these relationships as models to study other pesticides and other polymer systems in terms of retention times and desorption rates. Test promising new formulations or existing formulations for pest-parasite efficacy and host toxicity in cats, dogs and other domestic animals. Examine host-parasite metabolism of toxicants. Conduct field trials with more promising products.

PROGRESS: Concluded study on efficacy of aerosol sprays of Sendran and Sevin in control of fleas on dogs. Initiated and concluded study of irritant effect of Vapona-PVC resin collars on cats and dogs. Developed system for formulating pesticide in PVC plastisol. Tests for efficacy of PVC-pesticide formulations using mosquitoes, flies and fleas were developed and a program initiated. The feasibility of formulating insect attractants in PVC was studied and preliminary tests performed.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0078, THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS

R.L. GOULDING, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00097)

OBJECTIVE: Conduct investigations on arthropods affecting man and animals in order to develop information on: biological principles and techniques needed to design effective pest and disease vector control programs. Toxicological effects of newly developed pesticides on important arthropod parasites and disease vectors as well as pesticide residue problems. Economic importance of the effects on man and animals of these pests and disease vectors.

APPROACH: Test efficacy of new pesticides and other pest control techniques on a limited scale in Experiment Station animals and facilties followed by trials with the more effective materials or techniques under conditions representative of Oregon livestock management systems. Assess the toxicological effects of pesticides upon both individuals and population of hosts and parasites by means of appropriate studies in biochemistry, pathology and entomology. Where possible these studies will be related to possible economic effects as well as upon the more basic effects upon host-parasite physiologies and populations effects.

PROGRESS: Observation facefly problems in Oregon indicate irregularly distributed foci of annoyance with considerable temporal variations due to weather changes. Field observations on control techniques in use by ranchers continued. Cattle louse control trials involving the pesticide Gardona were initiated. A study on comparative pharmaco-dynamics of the pesticides Proban, Tiguvon and Ruelene in rabbits and feeding mosquitoes and ticks was concluded.

SUPPORTED BY Oregon State Government - Salem

2.0079, BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S.

UNKNOWN, U.S. Dept. of Agriculture, Entomology Research Division, *Corvallis, Oregon* 97331 (00ENTH0105390100)

OBJECTIVE: Determine distribution, abundance, taxonomy, and ecology of mosquitoes, sand flies, and gnats; study control by insecticides, chemosterilants, repellents, attractants, pathogens, predators and parasites in Western U.S.

APPROACH: Collect, identify, determine abundance of mosquitoes, sand flies, and gnats; evaluate chemical, physical, and biological control measures; develop basic information on ecology and taxonomy by laboratory and field methods. Conduct sterility studies with radiation and chemosterilants. Treat field test plots with candidate control agents--chemical or biological--and evaluate by standard entomological population determination techniques.

PROGRESS: Seventeen species of Culicoides gnats have been collected in the species composition and biology studies in Benton County, Oregon. Insecticide field tests with commercially formulated emulsions of Abate, Dursban, and fenthion with natural populations of snow-water Aedes gave 99% control in 3 plots treated with 0.05 lb/acre of fenthion and in 2 plots treated with 0.025 lb/acre of Dursban. Abate provided 99% and 100% control in 2 plots treated with 0.025 lb/acre but failed in 2 other plots. Chloroform extracts of log pond water were found to be highly attractive to ovipositing Culex pipiens quinquefasciatus mosquitoes. The microsporidia, Thelohania campbelli, was found infecting up to 80% of the Culiseta incidens larvae in log ponds near Corvallis, Oregon. Three of 72 compounds tested as repellents against Aedes aegypti and Aedes dorsalis, ENT 28740, ENT 33516, and ENT 33518, gave good repellency for 2 days at 1 g/ft .

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0080, DISTRIBUTION AND ECOLOGY OF PENNSYLVANIA SALAMANDERS

E.D. BELLIS, Penn. State University, Agricultural Experiment Sta., *University Park, Pennsylvania* 16802 (PEN01405)

OBJECTIVE: Determine ranges of nineteen species of salamanders in Pennsylvania; analyse distribution in relation to topography, vegetation, and other factors; investigate role of ecological factors in distribution of genetically controlled color differences.

APPROACH: Salamanders will be observed in natural habitats and collections made. Local populations will be studied by marking techniques. Laboratory studies will be carried out to determine influence of temperature and humidity on activities. Inheritance of color phase difference will be studied in relation to ecological factors. Gene frequency analyses will be carried out.

PROGRESS: Distribution patterns of salamanders were determined and several collections were made in central Pennsylvania, especially in western Centre County. Color patterns of red-spotted newts were analyzed and compared between 18 ponds; isolated ponds showed greatest extremes in color variation. Red-spotted newts were found to have small home ranges in ponds, to remain within home areas for extended periods and to show marked overland homing ability when placed on land 50 yards from the home area. Newts were experimentally shown to condition themselves to low atmospheric moisture, avoiding death by dehydration. Five methods of aging newts and efts (the land stage) were examined, none proved satisfactory but the studies revealed useful life history data. The food of newts in April, May and June was found to be very diverse, indicating that availability and not food preference determines the diet. Newts were shown to be valuable predators on mosquito larvae. Newts and efts differed significantly in the type and quantity of helminth parasites infecting them. The dusky salamander showed great homing ability when placed upstream, downstream, or at right angles to its stream habitat. Competition between dusky salamanders and the related Allegheny Mountain salamander is being analyzed to determine how they can occupy the same environment. Both species were shown to be randomly distributed when using uniform sized boards, placed along streams, for cover; they were neither territorial nor gregarious.

SUPPORTED BY Pennsylvania State Government

2.0081, INSECTS AFFECTING MAN AND ANIMALS

T.R. ADKINS, Clemson University, Agricultural Experiment Sta., *Clemson, South Carolina* 29631 (SC00830)

OBJECTIVE: Continue investigations with insecticides with emphasis on self-treatment devices. Continue investigations utilizing biological control agents against the face fly. Continue cattle grub control studies with pour-on and oral administration of systemic insecticides. Continue studies on house fly with insecticides and chemosterilants. Initiate investigations on the distribution and biology of eye gnats, black flies, mosquitoes and tabanids.

APPROACH: Basic investigations will be conducted to determine how and why dust bags control face flies and horn flies. Length of time required for cattle to accept the dust bags, how often they are used, the dust pattern on the animals, etc. will be investigated. Residue deposition in meat and milk will be studied. The face fly colony will be maintained with emphasis on the nutritional requirements of the fly. The colony of the staphylinid parasite-predator will be continued. Beetles will be released, then distribution, alternate food choices and survival will be studied. Cattle will be treated with pour-on and free- choice oral systemic insecticides. Efficacy correlated with time of treatment by the various chemicals will be determined. Barns will be sprayed with insecticides to determine the efficacy against house flies. Milk samples will be analyzed to determine if the chemicals or their metabolic products are deposited in the milk. Ecological studies will be initiated to determine the seasonal abundance, geographical distribution and specific breeding areas of eye gnats, punkies, black flies, mosquitoes, and tabanids.

PROGRESS: Tabanid investigations revealed more new records. One undescribed species of deer fly was collected. The advanced larval stage of 2 species of deer flies was reared to adults. Investigations were conducted on the attractiveness of a black ball under a plastic canopy to tabanids. This shape was superior to other geometric shapes. Aerial applications of dibrom (2 oz/acre), malathion (3 oz/acre), diazinon (3 oz/acre) were inferior to split application of malathion (3 oz - 13 oz/acre) for control of deer flies. All materials controlled mosquitoes. Breeding site of smoke fly, Microsania imperfecta, was not located. Nine species of punkies (Culicoides) were collected. Four species of black flies were collected.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0082, EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES

M.E. RIEWE, Gulf Coast Pasture Cattle Sta., *Angleton, Texas* 77877 (TEX01612)

OBJECTIVE: Determine the nature and extent of loss in production of beef cattle from high infestations of salt-marsh mosquitoes (Aedes sollicitans and Aedes taeniorhynchus). Ascertain the feasibility of chemical control of mosquitoes for beef cattle production. Determine the effectiveness of physical methods of mosquito abatment (water management) in salt-marsh pastures.

APPROACH: Four 75-acre pastures will be fenced in the salt-marsh and each pasture stocked with beef cows. Chemical mosquito control will be maintained on two pastures with the other two pastures left as a control. The animals will be individually sprayed in one treated pasture and one control pasture. Periodic weights on cows, calving percentage, and periodic and weaning weight on calves will be recorded. Mosquito population counts will be made by using traps and selected animals in each group. A test site adjacent to an inland bay will be surveyed for elevation and a main ditch cut from the lowest depression into the bay with feeder laterals from the minor depressions to the main ditch.

PROGRESS: Preliminary study of the effect of malathion applied as an aerial spray over the home range on population dynamics of the cotton rat (Sigmodon hispidus) was made. Following aerial applications of malathion to the rat's home range, malathion residues was detected by thin layer and electron capture chromatography in grass samples, rat stomach contents, and rat body tissues. Malathion did not appear to affect weight gains, radius of action, population density or reproduction of the rat. A survey was conducted from September, 1967 to November, 1969 to identify the macro-fauna inhabiting a West Galveston Bay marsh. Waters of the marsh were generally salty providing a habitat for a variety of marine and estuarine species. Marine species were found to enter shallow ponds outside the tide zone during tidal floods but generally became trapped and died as the result of fresh-water flooding, low winter temperatures or summer droughts. The presence of some large brown and white shrimp in these ponds suggested a potential for the commercial rearing of shrimp in marsh ponds or man-made ponds at elevations near mean high tide.

SUPPORTED BY Texas State Government - Austin

2.0083, ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST

R.H. KOKERNOT, Univ. of Texas, School of Public Health, *Houston, Texas* 77025

The principal aim of this research program is to study the factors implicated in the natural history of St. Louis encephalitis virus in the Texas Gulf Coast. Since many ecologic variables are involved, our aim is to measure quantitatively as many of these as possible. A surveillance of disease in the human population will be maintained in selected study sites, in which we will also establish a regular program of bird-netting, small mammal-trapping and collection of other vertebrates common to the area as well as of mosquitoes and other potential vectors. In conducting a well-integrated field-laboratory program it can be expected that arboviruses other than St. Louis encephalitis will be isolated. We aim to determine their identity and, when indicated, to attempt to establish their role in the health of human beings and domestic animals.

The ultimate objective of this research program is to determine factors in the natural history of these viruses that lend themselves to control and thereby permit public health workers to disrupt links in the chains of transmission. For example, as a result of observations made in this coastal region during the study of four epidemics due to St. Louis encephalitis virus, it would be sound public health practice to maintain a surveillance on the 'Culex p. quinquefasciatus' population to determine infection rates in order to implement efficient control measures.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. -
H.S.M.H.A

2.0084, SUSCEPTIBILITY OR RESISTANCE OF MEDICALLY IMPORTANT INSECTS TO INSECTICIDES ON SELECTED AIR FORCE BASES

W.F. PIPPIN, U.S. Air Force, Epidemiological Lab., *San Antonio, Texas* 78236

To monitor the action of standard Air Force insecticides on german cockroaches and mosquitoes at selected Air Force bases.

An AFB in Florida, Maine, Texas, Colorado, California, Washington, Alaska and Puerto Rico will be selected for testing purposes. Bases in these areas will provide a wide range of environmental conditions. Selected insect populations on these bases will be tested each year and trends, if any, noted in their resistance or susceptibility to insecticides. It will be necessary to rear the required insects in the USAFEL for testing.

SUPPORTED BY U.S. Dept. of Defense - Air Force

2.0085, MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT

M. HAFEZ, Cairo University, *Cairo, United Arab Republic* (480F4ENT6)

OBJECTIVE: By application of chemosterilants to house flies and anopheline mosquitoes in Egypt and through field experiments on isolated oasis determine feasibility of sterility principle of control for these insects.

APPROACH: Originate and maintain colonies of house flies and anopheline mosquitoes for preliminary evaluation of chemosterilants and to provide insects for field release. Evaluate different methods of chemosterilant application in laboratory. Select effective method of sterilizing these insects. Study biology and population dynamics. Conduct field tests on sterility principle by release and recapture technique.

PROGRESS: Musca domestica vicina formed about 90% of the total fly catch in Wadi El-Natroun. The highest percentage of M. sorbens (17%) occurred in January. Release and recapture experiments of M. d. vicina in Wadi El-Natroun showed flies dispersed more rapidly towards the village, covering a distance of 3 km in 24 hrs--apparently attracted to places where human dwellings and fly breeding grounds existed. An experiment in which 10,000 laboratory flies and 10,000 wild flies were released indicated most of the laboratory flies stayed near the release point while the wild flies dispersed more widely. The peak number of M. d. vicina was 1,762,500 flies in October. Sterilization trials with M. sorbens showed hempa to be superior to tepa. Sterilized laboratory males mated readily with wild flies and were sometimes more competitive than wild flies. Sterilization of M. d. vicina by dipping pupae provided flies with a high sterility level. The highest density of Anopheles pharoensis found in sleeping quarters was 3.3/room in July. Estimates of populations of Culex pipiens were obtained by release and recapture. From a release of 8,500 marked mosquitoes, the population in the area was indicated to be approximately 122,000 mosquitoes.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0086, SELECTIVE TOXICITY BY OPTICALLY ACTIVE PHOSPHONOTHIONATE PESTICIDES

W.A. BRINDLEY, Utah State University, Graduate School, *Logan, Utah* 84321

To test the biological activity of a new family by optically active organophosphate pesticides. To resolve these compounds into their optically active antipodes and to test them for selective toxicity with mammals and invertebrates. Promising compounds will be tested as control agents against mosquitoes and other military important arthropods.

Experimental compounds will be synthesized and tested by bioassay for toxiciy to invertebrates. Compounds will then be resolved into their optically active antipodes which will be selectively tested for toxicity with invertebrates and vertebrates.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0087, INSECTS AFFECTING MAN AND DOMESTIC ANIMALS

R.J. DICKE, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS00633)

OBJECTIVE: Chemical control of biting flies on dairy cattle and flies in dairy barns. Seek information on the chronological occurrence, relative abundance and general host preference of all bloodsucking flies attacking large and small mammals and birds in Wisconsin. These are groups which serve as vectors and reservoirs of disease agents and include mosquitoes, blackflies, horse flies, deer flies, and punkies.

APPROACH: Biological factors influencing the control of mosquitoes in urban areas. Emphasis is placed on the specific breeding sites and migratory habits of the principal pest species of an area such as Aedes vexans.

PROGRESS: Summer project was a study to determine the effect of light on the migratory and feeding responses of mosquitoes to a human host. The initial response (intense biting) is immediate and of short duration (about 20 minutes). At a site near Bruce, Wis. declining or increasing light was measured in the evening from 1830 to 2130 and morning from 0430 to 0730. The testing period extended from May 22 to Sept. 14, 1968 during alternate weeks with 46 samplings during the afternoon and 18 samplings during the morning. Light was measured every 15 minutes during each sampling at 5 points over the sky from east to west, and intensity of light was measured in the following bands: 325- 450 mu, 325-650 mu, 350-900 mu, and 750-1100 mu. At each light reading, 3 counts over 1 min. each were made of mosquitoes biting the investigator, and collected mosquitoes were identified to species. Meteorological conditions influence migration and feeding response only when temperatures are below 40 F or wind velocity is above about 15 miles/hour. Preliminary evaluation of data indicates that a positive response was triggered in the evening by a decrease in intensity of ultra-violet light energy and a relatively high level of infra-red light energy. In the morning, response is triggered by a relatively high level of infra-red to ultra-violet emitted by the rising sun. This preliminary conclusion seems to account for the continued feeding of mosquitoes during the day under a dense forest canopy, and their almost complete absence in open areas exposed to direct sunlight.

SUPPORTED BY Wisconsin State Government - Madison

2.0088, BIOLOGICAL FACTORS IN THE MANAGEMENT OF LAKE FLIES

W.L. HILSENHOFF, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01030)

OBJECTIVE: The ecology of the bottom fauna of Lake Winnebago and 14 other Wisconsin lakes, and the chemical and physical properties of these lakes are being studied to determine the factors that are responsible for nuisance population of midges. The biology of the Lake Fly, Tendipes plumosus, in Lake Winnebago is being intensively studied in the field and in the laboratory. The parasites and predators of T. plumosus are being investigated to determine their potential for biological control. Lakes treated by the Wisconsin Conservation Department with toxicants to remove undesirable fish populations are being studied to determine the effects of the toxicants on the bottom fauna and the effect of fish predation of this fauna.

SUPPORTED BY Wisconsin State Government - Madison

2.0089, ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES

F. MATSUMURA, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS00822)

OBJECTIVE: Explore the possibilities of using insect pathogens or any other naturally occurring compounds as insecticides. Study the mechanisms of action of various chlorinated insecticides on the nervous systems of animals. Investigate the fates of chlorinated hydrocarbon insecticides in the environments with particular emphasis on the microbial degradation of various pesticides.

APPROACH: The non insecticidal materials proposed for investigation are hormones, insect pheromones, chemosterilants and other naturally occurring insecticidal analogs. The major approach here is to conducts laboratory evaluation of new materials. In some cases attempts will be made to identify the toxic or active principles involved. Study the mode of action of insecticidal analogs, efforts will be made first to investigate the direct effects of biochemical means. Also efforts will be made to study the degradation enzymes which metabolize insecticidal substrates in various animals.

PROGRESS: A number of microorganism colonies were found to be capable of degrading chlorinated hydrocarbon insecticides. About 12 colonies were particularly active degrading dieldrin, endrin and aldrin. A number of hitherto unknown metabolites were chemically identified from the degradation products of dieldrin and endrin by these microorganisms. The mechanism of action of DDT was studied in the brain and the liver of the rat. DDT was found to preferentially bind in the synaptic junctions. DDT was also found to influence the function of ion transport by the liver tissue resulting in drastic alteration of the levels of other insecticides' storage. Also found that DDT influences the activity of ATPases in the nervous system. Efforts made to study the enzymes which hydrolyze various insecticidal organophosphates and carbamates. Each insecticide tested was found to be simultaneously hydrolyzed by a number of esterases. The nature of these esterases were studied. The metabolic fates of dieldrin in the rat were studied. Rat degrades dieldrin into 3 different metabolic products through different enzymatic mechanisms. Efforts made to study naturally occurring insecticides. A number of fungal products were found to possess potent insecticidal properties against mosquito larvae.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0090, EFFECT OF BITING FLIES ON WEIGHT GAINS IN CATTLE

J.E. LLOYD, Univ. of Wyoming, Agricultural Experiment Sta., *Laramie, Wyoming* 82071 (WYO00001-68)

OBJECTIVE: Determine weight gain difference between cattle protected from biting fly attack and cattle not protected and investigate new methods of biting fly control.

APPROACH: Certain cows and calves in herds will be protected from biting fly attack. The weight gains of these animals will be compared with those of unprotected cattle. Experimental compounds and promising methods of fly control will be used to protect the cattle.

PROGRESS: Two methods of fly control were investigated. Insecticide dust bags containing 1% Co-Ral (coumaphos) dust provided excellent control of horn flies on cattle. Difficulties with the dust bags were: (1) frequently cattle must be forced to use the bags, (2) no control of other biting flies or mosquitoes results, and (3) the rancher often does not have time to install the dust bags. Aerial application of malathion as ultra-low volume (ULV) gave inconsistent horn fly and mosquito control. We theorize that low air temperature at the time of application reduced the efficiency of the ULV malathion. We hope to have more success protecting cattle from biting flies and mosquitoes by using a repellent, possibly extended by an adjuvant. One-half of the cattle in each of two beef herds will be individually weighed and sprayed every two weeks.

SUPPORTED BY Wyoming State Government - Cheyenne

2B. AQUATIC WEEDS

(Submersed, Floating, Amphibious, or Riparian Plants and Aquatic Algae)

2.0091, CONTROL OF AQUATIC WEEDS BY USE OF N2-CO2-HE LASER SYSTEMS

R. COUCH, Athens College, Undergraduate School, *Athens, Alabama* 35611

The objectives are to develop the most economic and efficient source control methods for progressive control and eradication of specific aquatic plants. Preliminary studies with the High-Power N2- CO2-He Laser at Redstone Arsenal strongly indicate the potential value of laser systems for plant eradication. Approximately 200 individual laser tests will be necessary. The plant species of top priority and upon which the majority of gross cytological and morphological studies will be done to support the Laser Project I System. Development is water hyacinth, Eichornia crassipes. Other species listed from highest to lowest priority which will be laser irradiated and then require cytological and morphological examination are alligatorweed, Alternanthera philoxeroides; water chestnut, Trapa natens; eelgrass, Zostera marine; Cladophora; Pithophora; Chlorella; and water lettuce, Pistia stratioites.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0092, AQUATIC PLANT CONTROL BY HERBIVOROUS AMUR FISH

J.M. LAWRENCE, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830

This research is designed to determine the efficiency of the herbivorous Amur fish 'Ctenopharyngodon idella' as a biological control agent for aquatic weed populations in natural habitats, and to study the effects of released space and plant nutrients resulting from the destruction of weeds upon the aquatic ecosystem. The research will be conducted in lime sink ponds with natural weed populations. These ponds have no natural water outlet so that movement of fish into natural waters is eliminated. In addition, these ponds are all located on U. S. Army Corps of Engineers property or adjacent private property where access to the body of water is under complete control.

2. AQUATIC PEST CONTROL

SUPPORTED BY U.S. Dept. of Defense - Army

2.0093, CHEMICAL CONTROL OF WEEDS IN PONDS

J.M. LAWRENCE, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00427)

OBJECTIVE: Evaluate the activity of commercial and experimental herbicides and algacides on common pond weeds of this area. Determine the toxicological effects of the more promising aquatic herbicides and algacides to fish and fish-food organisms under controlled laboratory and field conditions. Investigate effects of more active aquatic herbicides and algacides on production of plankton, fish-food organisms, and fish in treated pools and ponds.

APPROACH: Twenty-five to 50 potential aquatic herbicides will be available for controlled laboratory evaluations each year. The more active of these herbicides will be evaluated in the laboratory for toxicity to fish. Controlled field evaluations of the most promising herbicides on 14 species of aquatic weeds and 2 species of fish will be set up each year.

PROGRESS: Treatments of diquat plus paraquat (.25 lb cation per acre of each) applied to Eurasian water milfoil (Myriophyllum spicatum) in spring provided control throughout summer, but no carry over of control was noted the following spring. Treatments of 2,4-DBEE granules (20 lbs per acre) applied to milfoil at same time eliminated infestation for 2 full summers, but treatments of 2,4-DBEE liquid (20 lbs per acre) provided control of milfoil for less than 6 weeks. Biological control of above-water growths of alligatorweed (Alternanthera philoxoides) with fleabeetle (Agasicles n.s.) resulted in suppression of regrowth for 8 to 10 weeks, and very limited regrowth for remainder of growing season. Chemical control with chlorophenoxy compounds resulted in complete kill of alligatorweed top-growth, but regrowth occurred within 4 weeks and three treatments were required per season to maintain satisfactory control.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0094, DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS

J.M. LAWRENCE, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00287)

OBJECTIVE: Determine the seasonal abundance of various algae in ponds with different levels of fertility. Determine the seasonal macro and micro nutrient composition of filterable suspended matter, the filtered water, and the hydrosol from ponds with different levels of fertility. Determine changes in nutrient and algal species composition associated with different algal control practices. Investigate techniques for management of algal species in ponds with different levels of fertility.

APPROACH: Samples of water, suspended matter and hydrosol will be collected from unfertilized, fertilized and fed fish ponds at various times throughout the year. Algae will be identified and its inorganic chemical composition determined. Inorganic composition of waters and hydrosols will also be determined. Changes in algal associations and chemical composition resulting from chemical and biological control practices will be investigated. Data accumulated in above investigations will be evaluated by appropriate statistical methods. Based upon data accumulated above, techniques for selected desirable phytoplankton and subsequent seeding into ponds will be investigated.

PROGRESS: Techniques to estimate the standing crop of major plant nutrients (N,P,K) in a farm pond were employed on a number of experimental ponds. The standing crop of nutrients within a 22-acre pond, which had received 51,500 lbs. of organic fish feed in the prior 7-month growing season are given below. Of the total 150 lbs/a N added in feed, 8.5 lbs/a was in solution, 15.6 lbs/a was in suspended matter (phytoplankton), and 46.9 lbs/a was in catfish. The other 79 lbs/a N was lost to air and soil. Of the total 18 lbs/a P added in feed, 1.2 lbs/a was in solution, 4.3 lbs/a was in suspended matter, and 17.3 lbs/a was in catfish. The 4.8 lbs/a P deficit was apparently supplied by the soil. A total of 26 lbs/a K was added in feed, but 48 lbs/a was in solution, 4.5 lbs/a was in suspended matter, and 2.6 lbs/a was in catfish. The 29.1 lbs/a K deficit was apparently supplied by soils in pond and watershed. The suspended matter (phytoplankton) was 95% Microcystis sp., with Rhaphidiopsis sp., Oscillatoria sp., and Spirulina sp. making up the other 5%.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0095, SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS

B.D. PERKINS, U.S. Dept. of Agriculture, *Buenos Aires, Argentina* (00ENTJ0203610100)

OBJECTIVE: Investigate the natural insect enemies of aquatic weeds in foreign countries; evaluate their host specificity; and collect and ship to the United States those species which will feed on or otherwise injure weeds.

APPROACH: Promising areas will be visited in countries where the weed is believed to have origniated, and when found, the weed is surveyed for its insect fauna. Studies will be conducted to gain as much ecological information as possible about the weed in these areas. Screening tests will be conducted to determine the degree of host specificity of the insects having the most potential for weed control. Species that pass the screening tests will be shipped to appropriate quarantine receiving stations in the United States as conditons permits.

PROGRESS: Host specificity tests with insects attacking Eichhornia crassipes were continued. Taxonomic studies of Neochetina bruchii weevils from several areas of Argentina indicated a species complex. All tests indicated N. bruchii and Neochtina n. sp. were specific to plants in the Pontederiaceae (Eichhornia, Pontederia). Chilo ignitalis was demonstrated to be host specific to Eichhornia and Pontederia. Tests with Cornops aquaticum, the hyacinth grasshopper, were inconclusive. Permission to introduce Chilo and Neochetina to the United States will be requested shortly. Surveys for insects attacking Elodea densa in Argentina were negative.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0096, EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS

P.G. BARTELS, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-2014-4159-003)

OBJECTIVE: Determine effect of ultrasound on morphology, physiology, and membrane permeability of various species of aquatic plants; determine relative differences in above effects as a function of frequency, intensity, and time of exposure to ultrasonic waves.

APPROACH: Several species of aquatic plants will be subjected to ultrasonic waves and examined microscopically for morphological changes in cells and their inclusions. Respiration and photosynthetic rates will be measured using standard Warburg manometric techniques and infrared gas analyzer techniques. Permeability changes in membranes will be studied using standard radioisotope absorption techniques. A variable frequency ultrasonic generator and various piezoelectric transducers will be used to vary frequency and intensity of ultrasonic waves. Exposure times also will be varied.

PROGRESS: We have been investigating the effects of ultrasound on the ultrastructure of plant cells. In the past, we have used the plant Chara as the experimental plant to sonicate since they are very susceptible to this treatment. Currently, we are doing similar experiments with Potamogeton and Elodea, which are two common aquatic weeds causing many problems in the U.S. waterways. The chloroplasts were found to be the first organelle of the plant cell which appears injured. The fret or large thylakoid membranes become disrupted and with continued ultrasonic treatment, the grana membranes are destroyed. Another symptom of the ultrasound treatment is the swelling of the fret and grana membranes. In addition, Mr. Sidlowski is building some new ultrasonic lenses in order to focus high intensities of radiation on to an area where the plants will be positioned. In constructing these lenses, several characteristics must be considered. First, the acoustic impedence of the lens material and the medium should be matched as closely as possible. The most convenient material that we used was plexiglass or polystyrene.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0097, WEED CONTROL IN RICE PRODUCTION

R.J. SMITH, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville*, *Arkansas* 72701 (ARK00419)

OBJECTIVE: Develop more effective chemical, cultural, mechanical, biological, and combination methods of controlling weeds in rice, and in crops grown in rotation with rice.

APPROACH: Evaluate and compare new herbicides and mixtures with standard ones. Determine the effects of weeds and herbicides on yield and quality of rice. Study the interactions of various control methods with the physiology, ecology, morphology, and anatomy of rice, and of annual and perennial weeds. Characterize the effects of selected herbicides on succeeding crops, fish, and other aquatic animal life. Determine the fate of herbicides, applied to rice, in the rice crop, soil, and water, and in other crops grown in rotation with rice.

PROGRESS: Postemergence treatments that combined propanil or molinate with one of several other herbicides controlled grass, broadleaf, and aquatic weeds better than standard treatments of either propanil or molinate applied alone. These treatments usually did not injure rice any more than propanil or molinate. Oryzalin at 3/4 to 1- 1/2 lb/A, CP-53619 at 1-1/2 to 4 lb/A, and RP-17623 at 3/4 to 1-1/2 lb/A each mixed with propanil at 3 lb/A and applied when the largest grass had 2 leaves, controlled emerged weeds and killed weeds that germinated during a 3 to 4 week period after treatment. Because these mixtures controlled weeds residually, they can be applied earlier than propanil, and irrigation after herbicide treatment can be delayed more than when propanil is used alone. Sequential treatments that included applications of either propanil at 3 lb/A, nitrofen at 1 lb/A, 2,4,5-T at 1/2 lb/A, or KN(3) at 2 to 4 lb/A after a treatment of propanil at 4 lb/A controlled weeds better than propanil at 4 lb/A alone. Mixtures of molinate and nitrofen at 2 1 lb/A and sequential treatments of molinate and KN(3) at 3 3 lb/A controlled weeds better than molinate alone.

SUPPORTED BY Arkansas State Government - Little Rock

2.0098, WEED CONTROL IN RICE PRODUCTION

R.J. SMITH, U.S. Dept. of Agriculture, Crops Research Division, *Stuttgart*, *Arkansas* 72160 (0710-01-05)

OBJECTIVE: To develop more efficient chemical, cultural, mechanical, biological and combination methods of controlling weeds in rice, and in crops grown in rotation with rice.

APPROACH: Evaluate and compare new herbicides and mixtures with standard ones; determine the effects of weeds and herbicides on yield and quality of rice; study the interactions of various control methods with the physiology, ecology, morphology, and anatomy of rice, and of annual and perennial weeds. Characterize the effects of selected herbicides on succeeding crops, and on fish.

PROGRESS: Several herbicides applied postemergence in mixtures and sequential combinations to drill-seeded rice controlled grass, broadleaf, and aquatic weeds better and increased yields more, than standard single treatments or sequential combinations of propanil, molinate, propanil 2,4,5-T, or molinate 2,4,5-T. An effective treatments that has shown promise for 1 to 3 years is a mixture of propanil with oryzalin, 2-chloro-2',6'-diethyl-N- (butoxymethyl) acetanilide.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

2.0099, BIOLOGICAL CONTROL OF WEEDS

L.A. ANDRES, U.S. Dept. of Agriculture, Entomology Research Division, *Albany*, *California* 94716 (00ENTJ0201050200)

OBJECTIVE: Determine the basic relationships between weeds and weed-feeding insects and carry out effectively all phases of a program designed to use insects as biological agents to control weeds.

APPROACH: After determination that a program designed to control a weed is necessary, a thorough study of the weed will be undertaken. This will include determination of its native habitat, distribution, and insect fauna. If the weed is of foreign origin, preliminary studies on host specificity may be undertaken at the Rome or Argentina laboratories and with the help of several PL 480 cooperators. Species will be shipped to Albany, where final tests will be made on specificity to the weed. After releases are made at suitable locations and populations have built up, the insects will be released to other locations. Evaluation of the insect as a control agent will be conducted.

PROGRESS: Releases of the Swiss biotype of Longitarsus jacobaeae adults to control tansy ragwort, Senecio jacobaea, were made in September, and November at Smith River, Del Norte County, California. The Italian biotype was released in August and October on 10-Mile River, Mendocino County, California. Two plants with larval damage were observed at Fort Bragg, California in May 1970, but larvae were not found. Tyria jacobaea populations increased significantly in Oregon and Washington in 1969. At Fort Bragg, Mendocino County, California, populations were high in localized areas and low in others. An evaluation of factors suppressing Tyria is underway. Releases of Altica carduorum to control Cirsium arvense at Fort Bragg failed to become established. Studies on the influence of native and naturalized insect species on the seed production of Salsola pestifer are underway. Agasicles n. sp. continues to spread and damage alligatorweed in the southeastern United States. The ratio of soluble carbohydrates to soluble nitrogen in phosphate-deficent alligatorweed was correlated with Agasicles feeding response. Feeding-behavioral tests with the alligatorweed moth, Vogtia malloi, were continued. Three-hundred fifty Phrydiuchus n. sp. weevils were released against Mediterranean sage, Salvia aethiopis, in Lake County, Oregon.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0100, AQUATIC WEED CONTROL RESEARCH

R.G. HOWARD, U.S. Dept. of Agriculture, Research Service, *Davis*, *California* 95616

Cooperative study of Aquatic Weed Problems in irrigation and drainage systems to include the following: (1) Conduct life history studies of submersed and emersed aquatic weed infesting large channels, lakes and reservoirs. (2) Field testing promising chemicals and mechanical devices for the control of submersed and emersed aquatic weeds in large irrigation channels, lakes and reservoirs. (3) Study the environmental requirements of Aquatic weeds in irrigation canals and ponds with emphasis on intensity and quality of light, water quality, and mineral nutrient supply. Investigate potential ecological competition with weed pests. (4) Conduct adsorption isotherm studies on aquatic soils with chemicals recommended for control of aquatic weeds. (5) Determine effects upon different aquatic weeds of various rates, formation and timing of application of selected herbicides in test canals. (6) Study effects of varying ecologic conditions and various chemical treatments upon aquatic biota such as clams, sponges, Bryozoa, etc.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0101, CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST

R.R. YEO, Univ. of California, Agricultural Experiment Sta., *Davis*, *California* 95616 (0710-02-01)

OBJECTIVE: Develop new or improved chemical, biological, and other methods for controlling weeds, Asiatic clams, and certain other aquatic pests in canals, lakes, reservoirs, and other aquatic situations. Determine the fate of herbicides, molluscicides, and other chemicals used in aquatic situations.

APPROACH: Search for and/or evaluate new and promising aquatic herbicides in greenhouse aquaria and flowing canals, outdoor pools, and closed system canals and in field canals and reservoirs. Conduct life history and ecological studies. Make samplings and analyses to determine the persistence of herbicides and molluscicides in water in natural canals and reservoirs and in small pools under controlled conditions. Evaluate fish, competitive plants, and other agents for biocontrol of aquatic weeds and other aquatic pests.

PROGRESS: Three acetals of acrolein were found to control submersed aquatic weeds in 2 canals for 6 mi at 7.5 to 10 ppm with 4 and 8 hr exposure. The hydrolysis of allylidiene diacetate to acrolein in 2 canals in which aquatic weeds were controlled peaked 2 mi downstream after 8 hrs with water at 19 C and 1 mi downstream after 2 hrs with water at 14.5 C. Acrolein applied at 4 ppm for 4 hrs plus a booster of 2 ppm for 3 hrs dissipated to .1 ppm after 32 mi. Diquat plus copper sulfate at .15 ppm controlled several aquatic weeds in reservoirs. Simazine, chloroxuron, copper metal, copper nitrate, igran, and diuron at 1, .5, 40, 4, .5, and .5 ppm, respectively, controlled Chara and Cladophora in growth pools without harming fish. Copper ion residue studies showed it to dissipate (in decreasing order) to non-detectable amounts fastest with copper nitrate copper sulfate - cuprose citrate - and copper metal. Copper sulfate circulated continuously with fresh weekly increments of 0.0, .1, 1. and 10 ppm of copper ion in aluminum irrigation pipe for 25 weeks did not seriously corrode the pipe. Slender spikerush was found highly effective in controlling aquatic weeds by competition in two irrigation canals.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

2.0102, BIOLOGICAL CONTROL OF WEEDS

R.D. GOLDEN, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2002-H)

OBJECTIVE: Effect the biological control of native and alien weeds of importance to California. Utilize native and alien weeds and their insect natural enemies as test vehicles.

APPROACH: Exploration for natural enemies, determination of host specificities, introduction under quarantine, and the colonization and distribution of these natural enemies in California. Suitable insect and weed species will be selected for field and laboratory investigations of host plant acceptance spectra, plant oriented taxi, and trophic behavior, as well as the dynamics, interdependency, and degree of mutual impact of field populations of phytophagous insects and their plant hosts.

PROGRESS: Alligatorweed (Alternanthera philoxeroides): The incipient colony of Agasicles n. sp. was destroyed by flash flooding of the Rio Hondo River in the Whittier Narrows flood control basin in Los Angeles County during the period of exceptionally high rainfall experienced by southern California in early 1969. Recolonization efforts will begin anew during mid-1970. Host-Plant Selection Studies: A photoanalytic technique for quantitatively assessing the feeding preferences of the leaf-feeding chrysomelid, Lema trilineata, a native natural enemy of the highly toxic jimsonweed, Datura spp., was developed. This method facilitates statistical analyses of the results of feeding tests and thus, where applicable, provides an objective means of interpreting the host affinities of candidate biological weed control agents. Ragweeds (Ambrosia spp.): Extensive and intensive surveys of the insect natural enemies of native and exotic species of ragweeds in southern California were initiated this year. A variety of insects that collectively attack all vital plant parts and that directly, and apparently indirectly, affect the production of ragweed pollen were collected and specimens have been submitted to appropriate systematists for identification. The feasibility of interstate and foreign exportation and intrastate manipulation and augmentation of monophagous species that hold promise as agents for the biological control of the more noxious species of ragweeds is being assessed.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0103, EVALUATION OF MANAGEMENT PRACTICES ON THE STATE-OWNED WILDLIFE AREAS

H. GEORGE, State Dept. of Fish & Game, *Sacramento, California* 95819

Objectives: To evaluate the various management practices carried on at State-owned wildlife areas.

Procedures: Management practices, including the propagation of food plants, water control development, grazing practices and control of undesirable plants will be checked and evaluated. Comparisons will be made between various management techniques to determine the most efficient and economical methods for obtaining maximum waterfowl use. Most of this investigation will be done in conjunction with the other marsh management studies that are made on these areas.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0104, WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS

R.R. YEO, State Dept. of Water Resources, *Sacramento, California* 95802

Cooperative study of the aquatic weed problems in irrigation and drainage systems to include the following: (1) Conduct life history studies of submersed and emersed aquatic weed infesting large channels, lakes and reservoirs. (2) Field testing promising chemicals and mechanical devices for the control of submersed and emersed aquatic weeds in large irrigation channels, lakes and reservoirs. (3) Study the environmental requirements of aquatic weeds in irrigation channels and ponds with emphasis on intensity and quality of light, water quality, and mineral nutrient supply. Investigate potential ecological competition with weed pests. (4) Conduct adsorption isotherm studies on aquatic soils with chemicals recommended for control of aquatic weeds. (5) Determine effects upon different aquatic weeds of various rates, formation and timing of application of selected herbicides in test canals. (6) Study effects of varying ecologic conditions and various chemical treatments upon aquatic biota such as clams, sponges, bryozoa, etc.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0105, PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES

P.A. FRANK, U.S. Dept. of Agriculture, Crops Research Division, *Denver, Colorado* (0710-02-02)

OBJECTIVE: Improve existing methods available for the control of submersed aquatic weeds, and develop information which may ultimately lead to the use of new and more effective weed control principles and practices. Improve and develop chemical procedures for analysis of herbicides, determine the residues resulting from their use in and near water, and provide data which will facilitate registration and use of the the materials as aquatic-weed herbicides.

APPROACH: Conduct an evaluation program to determine the herbicidal activity and potential usefulness of new herbicides and experimental materials. Arrange preliminary field trials of promising materials. Study absorption and translocation of herbicides and developmental physiology of representative weed species. Treat canals, ponds, and ditchbanks; collect soil and water samples for residue and degradation studies.

PROGRESS: Dissipation of 2,4-D dimethylamine at 133 and 254 ppb in irrigation water, was linear for distances of 6 and 7 mi of water flow. Residues were reduced more rapidly than for other water soluble herbicides tested. Dye used as a model of herbicide dissipation indicated dye cloud elongation rates of 12 to 18 minutes per mile. Reductions in maximum dye concentration between the 0.25 mile and 8 mile stations were 74, 47, and 32% for the 2500, 4400, and 6600 ft treatments, respectively. Studies on dissipation of xylene in irrigation water showed that treatment rates of 550 to 600 ppm were reduced as rapidly as 92% after 4 mi of water flow in 1 canal, to as little at 77% after 10 mi of flow in another canal. Bluegill and trout were killed by the xylene 9 and 10 mi downstream from the treatment sites. Spring time soil samples from ditchbanks treated in the fall with 70 lb per A TCA had residues of 1 to 44 ppm in the surface inch, and 1.3 to 10 ppm in the 2 to 4 inch soil layer. Very low and transitory levels of TCA occurred in water the next spring. Established that loss of the PGBE ester from water is due largely to loss of emulsion with the ester settling to the soil surface. After 4 and 12 hr, loss of silvex from water was 83 and 91%, respectively. Containers of glass, polyvinyl chloride (PVC), high and low density polyethylene (HDP, LDP) were adequate for storing TCA and diquat. BEE of 2,4-D stored well in all but LDP. Only glass and PVC were suitable for storing dichlobenil.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

2.0106, INVESTIGATIONS OF ALGAE INHIBITING MATERIALS

T.R. BARTLEY, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Attached aquatic organisms seriously reduce the carrying capacity of irrigation and water distribution structures. Laboratory and field studies show that by coating these structures with appropriate materials containing toxicants the organisms will not develop on the coated area. Coatings under study include antifouling paints, direct metal coatings to concentrate incorporation of toxicants in the concrete surface, and various other materials applied to the surface of the submerged concrete. The most promising results to date indicate that certain antifouling paints, a vinyl-resin system of cuprous oxide or tributyl tin oxide, applied to submerged concrete will provide long-term inhibition of algae attachment. The present program has progressed sufficiently to provide recommendations for routine field use of specified materials on submerged concrete structures. These antifoulifg coatings are presently limited to small areas, such as concrete weirs and flumes, because of cost.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0107, AROMATIC SOLVENT AQUATIC HERBICIDES AND EMULSIFYING AGENT TESTING

T.R. BARTLEY, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Certain aromatic hydrocarbon solvents are used extensively by the Bureau of Reclamation and cooperating irrigation districts for controlling submersed aquatic weeds. These materials are seldom available in quantity as formulated aquatic herbicides, but are often products of petroleum or coal-tar distillations that differ in makeup. Large-scale acquisition of these byproducts requires laboratory testing and evaluation for determining suitability as aquatic herbicides. Studies have shown that aromatic solvents must have specific physical and chemical properties, as well as proper dispersion in irrigation water by emulsifiers. Physical, chemical, and biological laboratory tests are conducted on samples of aromatic solvent materials and emulsifying compounds to determine whether they meet specifications and are effective as aquatic weed herbicides. These samples are submitted to the laboratory from Bureau field offices, manufacturers, and suppliers.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0108, EFFECT OF COPPER SULFATE ON AQUATIC WEEDS

T.R. BARTLEY, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Laboratory studies and experiments by other investigators have shown that copper has a pronounced effect on aquatic vegetation. Copper has been used for many years as an effective algaecide. This study was undertaken to determine the effects of a continuous or semicontinuous feed of low concentrations of copper on the growth of aquatic weeds and algae common to Western irrigation canals.

Small copper sulfate crystals are fed into the flowing water at a calculated rate based on water volume by means of automatic feeding devices. The copper sulfate is fed into the water daily throughout most of the irrigation season. The aquatic weed growth will be observed frequently through the season to determine the effect of the treatment. Concentration of copper in the irrigation water will be monitored. Total alkalinity of water on copper concentrations is being investigated. Water temperature and other factors are investigated in this aquatic weed control study.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0109, HERBICIDE RESIDUES

T.R. BARTLEY, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

The project, conducted in cooperation with the ARS, U.S. Department of Agriculture, and BSF&W, Department of the Interior, involves the determination of herbicide residues in water, soils, and plants following the application of herbicides for control of aquatic and ditchbank weeds on irrigation systems. Data on herbicide residues and their dissipation rates are needed to support petitions for registration, establish safe tolerances for irrigation water, improve the Efficacy of herbicide use, and to establish safety in herbicide applications. Pesticide legislation requirements stipulate that these data must be furnished in support of a petition.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0110, GROWTH SUPPRESSION AND REDUCTION IN REGROWTH POTENTIAL OF AQUATIC WEEDS

N.E. OTTO, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Successful continued control or irradication of rooted submersed aquatic weeds requires information on methods to reduce or eliminate the regrowth potential of the aquatic plant to a point where they produce insignificant problems. Studies have been conducted to gain a better understanding of organism ability to reporduce inself in subsequent growing seasons. These studies include: evaluation of new herbicidal compounds and techniques, influence of treatment on stage of growth, number and type of herbicide applications necessary to reduce the amount of vegetative growth and propagule development, amount of propagative material produced by a clone of plants and food reserves in the propagule.

Laboratory investigations show that pondweeds treated with repeated herbicide applications in one growing season significantly reduced vegetative propagule production. Continuing laboratory and field studies suggest that low rate, long contract period applications of a number of aquatic herbicides show promise in significantly suppressing the growth of rooted aquatic weeds, thus reducing potential residue hazards as well as controlling weed growth. Studies are conducted on a continuing basis as new aquatic herbicides and weed control techniques are suggested.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0111, LABORATORY STUDY OF AQUATIC ENVIRONMENTAL FACTORS AND PLANT GROWTH STAGES ON AQUATIC WEED GROWTH AND HERBICIDAL RESPONSE

N.E. OTTO, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

The effectiveness of aquatic herbicides often varies in the same canal system. The factors responsible for these variations in herbicidal response are seldom determined, but might be ascribed to variations in environment or plant material. Laboratory studies are being conducted to evaluate environmental factors, such as light, temperature, and plant growth stage on the development of aquatic weeds and response to herbicidal treatment. Laboratory studies are conducted in two controlled environmental growth chambers. Results show that controlled environmental variations of light and temperature exert considerable influence on the growth and development of two pondweed species studied. These studies also show that the morphological growth stage (relative age) attained by aquatic plants was a major determinant in the degree of injury obtained from treatment with two types of aquatic herbicides. Studies are conducted on a continuing basis as new aquatic herbicides and weed control techniques become available.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0112, AQUATIC PEST CONTROL

N.E. OTTO, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Laboratory and field studies will be conducted to discover, develop, and improve methods of controlling rooted aquatic weeds and algae that infest water conveyance systems. Chemical, biological, mechanical or environmental manipulation methods for control will be considered and investigated. Techniques directed toward target organisms without introduction of materials or residues harmful to other organisms or the environment are to be emphasized. Aquatic plant pests infest over one-half of the conveyance channels in the 17 western states and cost of controlling these organisms amounts to as much as 40 percent of the total operation and maintenance expenditures. The Bureau and the Agricultural Research Service, USDA, are working cooperatively in this research program. Studies specifically include such items as: investigations of the ecological relationships of plants and animals in the canal environment; nutrient requirements of algae and higher aquatic plants; effects of copper sulfate on rooted weeds and algae when fed at low rates, including effects of water quality on the treatment; effects of growth stages and environmental factors on the growth suppression and regrowth potential of aquatic weeds; routine evaluation of experimental herbicide chemicals and promising new tecniques; evaluation of algae inhibiting materials such as antifouling coatings; and study of the relationship of micro-organisms in aquatic soils and how they influence growth of higher aquatic plants to determine if micro-organism control can limit higher plant growth.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0113, CONTROL OF AQUATIC WEEDS

J.F. AHRENS, Univ. of Connecticut, Agricultural Experiment Sta., *Storrs, Connecticut* 06268 (CONH00607)

Progress: In the late fall of 1967 dichlobenil was applied to an irrigation pond to control aquatic weeds in 1968. Water samples were taken at 1, 2, 3 and 4 months after treatments, frozen and later assayed to determine residual phytotoxicity. Oat seeds were watered with 1/2 or 1 inch of the water samples and root growth was measured. Water samples taken at 1 or 2 months severely injured oats but later samples caused no injury. The pond was essentially weed free during 1968 and the water was used to irrigate container nursery stock. To determine the residual effects of 2,4-D in water, 2,4-D butoxyethanol ester in granular form was applied in 2 farm ponds at 1 and 5 ppm. Water samples were taken at weekly intervals up to 36 days after treatment and will be analyzed for 2,4-D by Amchen Products, Inc.

SUPPORTED BY Connecticut State Government - Hartford

2.0114, CHEMICAL CONTROL OF DITCHBANK WEEDS IN PEAT AND SANDY SOIL AREAS OF SOUTH FLORIDA

J.R. ORSENIGO, Everglades Agric. Expt. Sta., *Belle Glade, Florida* 33430 (FLA-EV-01029)

OBJECTIVE: Evaluate soil sterilants and post-emergence herbicides for effectiveness in control of ditchbank weeds on peat and sandy soils.

APPROACH: Commercial and promising experimental soil sterilant and post-emergence herbicides are evaluated in typical weed infestations on sandy and peat soil ditchbanks. Herbicide performance is rated periodically for individual major weed species response, survival and reinfestation. Observations may continue for periods of six months or more. Granular and sprayable herbicide formulations and times and methods of chemical application are compared; i.e., dalapon applied alone in repeated light dosages has provided paragrass control superior to single heavy treatments of dalapon alone or in combinations with other herbicides.

PROGRESS: Ditchbanks and fencerows are ideal habitat for development of dense stands of Napiergrass (Pennesitum purpureum) which spreads vegetatively and by seed to adjacent crop fields where it can become a dominant infestant. Control programs may fail if seedlings develop after crops, especially sugarcane, are too large for mechanical or chemical treatment. The Napiergrass population multiplied between application and harvest in a rigorous chemical control experiment in a sugarcane field. A seven-fold increase in stool counts developed in the untreated controls and a two- to three-fold increase was recorded under soil sterilant and foliar-spray programs. Practical control of Napiergrass in crop fields will depend on effective ditchbank and fencerow programs.

SUPPORTED BY Florida State Government - Tallahassee

2.0115, BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST

K.K. STEWARD, Florida Agric. Expt. Station, *Fort Lauderdale, Florida* 33310 (0710-02-05)

OBJECTIVE: Develop more effective and economical methods of controlling aquatic vegetation in waterways, canals, lakes, ponds in ways to minimize herbicide toxicity to the environment.

APPROACH: Study the growth requirements and patterns of aquatic plants as related to nutrition, light, temperature and other aspects of environment. Study life cycles and reproduction of aquatic weeds to determine optimum chemicals and times for control applications. Study the selectivity, absorption, and translocation of herbicides in plants and their persistence in the aquatic environment.

PROGRESS: Seven amine salt formulations of 2,4-D were evaluated in static water tests on the 2,4-D resistant submersed weeds Vallisneria and Egeria. The oleyl amine was most phytotoxic and a mixture of dodecyl-tetradecyl amines was next. Complete control was obtained at 5 ppmw in 2-4 weeks. A technique of applying herbicides to specific plant zones to increase effectiveness was assessed on the floating weed water hyacinth. Eight formulations of oil soluble herbicides were mixed in kerosene and applied to the root zone by floating the oil on the water surface. None of the treatments produced a phytotoxic response greater than the standard foliar application. Two silvex and one 2,4-D ester formulations were comparable at equivalent rates. Injury from diquat and amine salt of endothall applied to intact isolated stem regions of Hydrilla, Vallisneria, and Eurasian watermilfoil was restricted to tissue actually in contact with the herbicide. No translocation to other regions was apparent. Of 22 chemicals evaluated for effects on sprouting and regrowth of vegetation propagules of Hydrilla, dichlobenil was the most active. Shoot growth was completely inhibited at a concentration of 0.05 ppmw in continuous contact for 6 weeks. Herbicides incorporated into plastic pellets for slow controlled release into water were evaluated for phytotoxicity toward Eurasian watermilfoil. In static water tests a 0.1 ppmw rate of fenac acid produced 94% control in 8 weeks.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

2.0116, EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS

R.D. BLACKBURN, Plantation Field Laboratory, *Fort Lauderdale, Florida* 33310 (FLA-PL-01124)

OBJECTIVE: Evaluate chemical compounds for their herbicidal activity against submersed, emersed, and floating aquatic weeds.

APPROACH: New herbicides will be evaluated on 3 submersed aquatic weeds (Elodea densa, Najas guadalupenis, and Ceratophyllum demersum); 3 species of floating aquatic weeds (Eichhornia crassipes, Salvinia rotundifolia, and Pistia stratiotes); and one emersed aquatic weed (Alternanthera philoxeroides). Submersed Weeds: Evaluations will be done in a temperature and light intensity controlled laboratory. Application rates will vary from 1 to 10 ppmw or ppmv and contact time of herbicides with plant will be varied from 30 minutes to 4 weeks. Visual evaluations will be made at various intervals. Floating Weeds: Plants will be grown in plastic containers in a greenhouse. Application rates of herbicides will vary from 1 to 10 lb/A of active ingredient. Visual evaluations will be made at various intervals. Emersed Weeds: Floating mats of alligatorweed will be grown in plastic containers in a greenhouse. Application rates will be 5 and 20 lb/A of active ingredient applied as a foliar spray. Visual evaluations will be made at various intervals to determine the percent topkill and percent regrowth. Herbicides that show herbicidal activity on any of these weeds will be further evaluated in growth pools constructed near the laboratory.

PROGRESS: A combination of copper with diquat, endothall, and ametryne increased herbicidal activity on hydrilla.

Ametryne (3 lb/A) applied in combination with 2,4-D (1/8lb/A) controlled water hyacinth. A granular and slow release pellet of the amine salt of endothall have controlled hydrilla in lakes. The slow release pellet has given longer control in lakes and flowing canals. Cost of control and fish toxicity has been reduced when using slow release pellets. A weighted formulation of the amine salt of endothall has controlled hydrilla in flowing canals. Diquat, endothall, and copper sulfate have been encapsulated into a slow release capsule. Plastic enclosures (25 Sq. ft.) have proven to be an excellent research tool for evaluating herbicides on submerged aquatic weeds.

SUPPORTED BY Florida State Government - Tallahassee

2.0117, ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST

R.D. BLACKBURN, U.S. Dept. of Agriculture, Crops Research Division, *Fort Lauderdale, Florida* 33310 (0710-02-04)

OBJECTIVE: Develop effective and safe biocontrol methods of controlling aquatic weeds. Determine the effects of herbicides on biological control agents, fish, and other desirable organisms in the aquatic environment. Determine the changes in the aquatic environment when using biological, mechanical, and herbicidal control.

APPROACH: Study the life histories and ecology of biocontrol agents as related to the control of aquatic weeds. Conduct laboratory, growthpool, and field experiments to determine refinements in the most effective and safest techniques of utilizing biocontrol agents alone and in combination with herbicides for control of aquatic weeds. Evaluate in controlled environmental and field conditions the toxicity of herbicides to biocontrol agents, sports fish, and the aquatic environment.

PROGRESS: Hydrilla has replaced the submersed weeds southern Naiad and Vallisneria in the freshwater canals and lakes of Florida. Regrowth in herbicidal treated areas is primarily from stem nodes and underground tubers. Diquat and paraquat were evaluated over a 3-year period in ponds to determine their effects on the fishery environment. The herbicide had an initial effect on the plankton but it recovered in 30 days after treatment. Diquat showed an acute toxicity to the amphipod Hyalella. Water quality was affected for a period of 10 to 14 days after treatment with both herbicides. Both herbicides could be used in the aquatic environment without long term effects. The Pomacea snail can be grown in the laboratory. Circulating water has been necessary for rapid growth. The snail feeds vigorously on aquatic weeds.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

2.0118, THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST

L.W. WELDON, U.S. Dept. of Agriculture, Crops Research Division, *Fort Lauderdale, Florida* 33310 (0710-02-03)

OBJECTIVE: Develop methods of controlling aquatic vegetation in waterways, canals, lakes, ponds, and irrigation systems.

APPROACH: Evaluate new chemicals and additives to herbicides to increase effectiveness on elodea, Eurasian watermilfoil, water hyacinth, alligatorweed, and other aquatic plants. Study life cycle of the plants and environmental factors affecting the carbohydrate reserves, plant response to herbicides, and persistence of herbicides in the water, plant, organism, and hydrosoil.

PROGRESS: Ametryne (3 lb/A) applied in combination with 2,4-D (1/8 lb/A) controlled water hyacinth. A granular and slow release pellet of the amine salt of endothall has controlled hydrilla in lakes. The slow release pellet has given longer control in lakes and flowing canals. Cost of control and fish toxicity have been reduced when using slow release pellets. A weighted formulation of the amine salt of endothall has controlled hydrilla in flowing canals. Diquat, endothall, and copper sulfate have been encapsulated into a slow release capsule. Plastic enclosures (25 sq. ft.) have proven to be an excellent research tool for evaluating herbicides on submersed aquatic weeds.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

2.0119, PROCESSING, CHEMICAL COMPOSITION, AND NUTRITIVE VALUE OF AQUATIC WEEDS

L.O. BAGNALL, Univ. of Florida, Inst. of Food & Agric. Sci., *Gainesville, Florida* 32601

Laboratory and field investigation of the processing and feeding properties of aquatic weeds, particularly Water hyacinth and Florida Elodea, will be conducted to determine under what conditions they may be economically utilized after having been harvested to clear lakes and streams. Plants will be processed by mechanical dewatering, evaporative drying, and pelleting. Water removal, nutrient removal, and costs of processing will be determined. Chemical analyses of products and byproducts will determine nutrient and toxicant content. Animal feeding trials will determine voluntary intake, live-weight changes, digestive disorders, and apparent digestibility.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0120, SOUTHEASTERN BIOLOGICAL CONTROL OF WEEDS INVESTIGATIONS

N. SPENCER, Univ. of Florida, U.S.D.A. Entomology Res. Div., *Gainesville, Florida* 32601 (00ENTJ0212100100)

OBJECTIVE: Develop and apply methods for utilizing insects to control aquatic weeds, with special emphasis on control of waterhyacinth.

APPROACH: Information will be obtained on the identity, biology, and distribution of the insect and mite fauna of waterhyacinth in Florida and elsewhere in the United States. Those insect and mite species having potential value as biological control agents will be identified by field observation and laboratory experimentation. Host- specificity studies on foreign species of insects will be carried out prior to colonizing them in the United States to control waterhyacinth or other aquatic weeds. Alligatorweed flea beetle and other introduced insects having promise in control of aquatic weeds will be thoroughly evaluated to determine factors influencing the range of their effectiveness in various ecological situations.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0121, BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS

F.W. ZETTLER, Univ. of Florida, School of Agriculture, *Gainesville, Florida* 32601

The proposed research plan involves field and laboratory investigations directed at the control of aquatic weeds through the use of plant pathogens. The main approach in the investigations is to collect and identify the diseases of aquatic plants in their native habitat and to assess their potentials as biological controls of specific pestiliferous water plants.

Field investigations would include the following: 1. Visiting the native habitats of the introduced aquatic weed species in search of their plant pathogens: 2. Determining the role of these pathogens in suppressing plant population explosions: 3. Collecting and identifying promising pathogens preparatory to their being studied in the laboratory.

Laboratory investigations would employ the following methods: 1. Pathogenicity studies in which the effects of the pathogens on various plants, including beneficial species, would be assessed: 2. Culturing experiments designed to determine optimal conditions for pathogen development: 3. Transmission studies in which natural and artificial means of inoculation would be investigated and related to the aquatic environment.

Laboratory and field data would be correlated for practical means by which to employ pathogens in controlling water weeds in open Florida waters.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0122, BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS

F.W. ZETTLER, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-PT-01517)

2. AQUATIC PEST CONTROL

OBJECTIVE: Controlling aquatic weeds biologically utilizing plant pathogens.

APPROACH: Searching for diseases of aquatic plants in USA and abroad. Identifying and characterizing the causal organisms involved. Assessing their pathogenicity to pestiferous and beneficial plants. Exploiting them as biological control of aquatic plants.

SUPPORTED BY Florida State Government - Tallahassee

2.0123, WEED CONTROL IN CITRICULTURE

R.L. PHILLIPS, Citrus Agricultural Expt. Sta., *Lake Alfred, Florida* 33850 (FLA-CS-00945)

OBJECTIVE: Devise effective, safe, and practical methods of using herbicides for controlling weeds in and adjacent to citrus plantings and sites. Study the effects of herbicides on citrus trees.

APPROACH: Control of weeds in groves and nurseries -- Field trials will be established to evaluate the effectiveness of diuron, simazine, and EPTC on control of annual weeds in groves nurseries. Repeated low rates of dalapon will be studied for perennial grass control in groves. Control of aquatic and ditchbank weeds in coastal groves. Several commercially available soil sterilant and growth-regulator type herbicides will be evaluated for control of submersed and emergent aquatics and ditchbank vines, brush and perennial grasses in coastal grove ditches. Residual effects of annual or semi-annual applications of herbicides on tree growth and yield will be studied. A continuous program of screening new herbicides will be conducted.

PROGRESS: Dichlobenil has continued to give excellent control of a wide number of weeds. After 2 applications the first year, only 1 application per year has been required for satisfactory control. Results with diuron were also favorable but control did not last as long. Control with terbacil was not satisfactory in some cases because tolerant weeds were present. The addition of paraquat increased the effectiveness of diuron and terbacil where larger weeds were present when applied. Treflan gave excellent control of annual grasses but tolerant weeds were not affected in many plots. Several new herbicides were tested. GS-14254 and VCS-438 showed promise for use in citrus groves because of their long-lasting effects on weed growth and their low toxicity to citrus trees. Vine control studies were made using growth regulators, preemergence herbicides and contact herbicides. In general, 2,4,5-TP was the most effective phenoxy herbicide tested. The addition of surfactants and non-phytotoxic oils increased its effectiveness. Casoron was the most effective preemergence herbicide tested, followed by the triazines. Contact herbicides resulted in good control with frequent applications.

SUPPORTED BY Florida State Government - Tallahassee

2.0124, MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS

R.D. BLACKBURN, Univ. of Miami, School of Arts, *Miami, Florida* 33124 (0710-02-11(C))

OBJECTIVE: Determine physiological and environmental factors that influence the reproduction of the large, fresh-water snail Marisa cornuarietis; develop techniques for mass rearing the snail; determine methods and economics of shipping the snail to potential weed-infested ponds and lakes in temperate climates; produce sufficient number of snails for large-scale stocking of weed-infested ponds in temperate climates.

APPROACH: Collect races of Marisa from Florida, Puerto Rico, the Caribbean, and South America. Determine survival, growth rate, and reproduction of snails as a function of physical environment and age. Determine differences in races with regard to fecundity, longevity, weed consumption, and other factors affecting overall biotic potential as biological weed control agents. Select most promising strains or races and develop methods of mass rearing, handling, harvesting, and transportating snails to temperate waters. Conduct preliminary field trials of mass-reared snails for control of aquatic weeds in temperate waters. Evaluate overall cost and effectiveness of the potential biological control system.

PROGRESS: Crowding does not increase mortality, but does decrease growth rate. Crowding also increases shell erosion, especially in small snails. Amount of available light produced no significant changes in shell erosion. Sexes can be differentiated by shape of aperture. Egg capsule membrane and fluid are indicated as regulators of ionic and water balance. Addition of high protein fish concentrate, snail eggs, and snail bodies to the diet do not increase growth. Newly hatched snails gain about twice as much total body weight as weight of fish pellets fed. This rate decreases to about 1:1 for juvenile snails. Primary source of DDT residue in marisa is from food chain rather than absorption directly from waters.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

2.0125, TESTING OF NEW HERBICIDES

W.W. THOMASTON, State Game & Fish Commission, *Atlanta, Georgia* 30334

Study Objective: To evaluate methods and materials or controlling weeds in small impoundments and to study reasons for their existence in particular areas.

Job Objective: To evaluate the effectiveness of new herbicides on various species of aquatic weeds.

Procedures: New herbicides will be tested to determine the feasibility of using these chemicals for control of various aquatic weeds. The number of experiments will be determined by their availibility and satisfactory ponds for this work.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0126, TESTING OF METHODS OF HERBICIDE APPLICATION

W.W. THOMASTON, State Game & Fish Commission, *Atlanta, Georgia* 30334

Study Objective: To evaluate methods and materials for controlling weeds in small impoundments, and to study reasons for their existence in particular areas.

Job Objective: To find the most suitable and simplified method of applying individual herbicides.

Procedures: Herbicides will be applied by using established simplified techniques, such as gravity flow and spraying. Other simplified methods will be devised and evaluated. The number of ponds is dependent on existing situations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0127, SURVEY OF POND WEEDS AND PLANT SUCCESSION

W.W. THOMASTON, State Game & Fish Commission, *Atlanta, Georgia* 30334

Study Objective: To evaluate methods and materials for controlling weeds in small impoundments, and to study reasons for their existence in particular areas.

Job Objective: To determine the area and conditions necessary for the growth of aquatic weeds.

Procedures: A survey of the frequency of ponds infested with aquatic weeds as related to the water quality will be made. When possible, the succession of plants in an area will be determined.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0128, AQUATIC PLANT CONTROL

A.B. MONTGOMERY, U.S. Dept. of the Interior, Bureau of Sport Fish. & Wlfe., *Atlanta, Georgia* 30323

The ever-increasing demands on water resources of this country are being severely curtailed by the rapid encroachment of obnoxious aquatic plants. This has resulted in the necessity for control of interfering aquatic weed infestations. Such is most effectively accomplished through the use of chemicals. However, the chemicals must be harmless to aquatic organisms and safe for uses associated with human water supply.

The objectives of the investigation are to determine the effects of herbicides, used in the control of obnoxious aquatic plants, to fish and related organisms and their environment. Pre-, during and post- treatment data will be collected from field study areas which are treated under operational procedures. Standard fisheries collecting equipment and methods will be used. The studies will include acute and chronic toxicities of the chemicals, as well as residues which are accumulated in the various tissues and organs of the organisms, bottom muds and the water. Laboratory studies will be conducted as are deemed necessary and beneficial. In addition, the good or bad effects of alteration of the habitat through plant removal will be evaluated. This is a continuing study and will consider different plants, environments, and chemicals.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0129, THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST

L.W. WELDON, U.S. Dept. of Agriculture, Crops Research Division, *Savannah, Georgia* 31405 (0710-02-03A)

PROGRESS: A combination of biocontrol (Agasicles beetle) and chemical (silvex) was more effective in controlling alligator weed than either used alone. The Agasicles beetle is well established on alligator weed from Charleston, S.C. to Florida, Alabama and Texas. The beetles overwintered in all study sites in 1969. Beetles are effective deterents to the growth of alligator weed. Thrips (Thysanoptera) have been found feeding on alligatorweed in North Florida. Large areas of fragrent water lily were controlled using 5 lb/A of dichlobenil. Southern water grass was effectively controlled with 2 lb/A of paraquat. A combination of copper with diquat, endothall, and ametryne increased herbicidal activity on hydrilla.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

2.0130, THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS

S. EHRLICH, Justus Liebig Universitat, *Giessen, Germany*

The 1000 ha Agras Reservoir is sited on fertile reed-peat soil. Its depth is 0-2 m, only the canals having a depth of 3.5 m. It stores the water for a day of operation only. The daily water change and almost continuous flow suppress development of microscopic algae and enhance the growth of attached weeds. The conditions of the lake are favorable for a large number of aquatic plant species. The use of water for watering of cattle and irrigation excludes chemical control. Mechanical cutting of submergent weeds caused only gradual replacement of Potamogeton and Polygonum by Chara. Stands of emergent vegetation destroyed by nutria were replaced by submergent vegetation.

The aims of the project are: 1. To control the emergent weeds by developing a nutria population sufficiently aggregated under conditons of low mean density to control the vegetation in the colony areas and later continuing rapid reproduction, enabling commercial exploitation, under conditions of high mean density. 2. Due to the large number of submergent plant species a number of plant-eating animals will be used for control: grass carp, wild water fowl specially introduced in the lake (mute swan and Netta rufina), wild water fowl enhanced in the lake (water hen), domestic and semi-domestic ducks. 3. Enhancing the growth of Lemna in the numerous bays and ponds partly isolated by dykes of peat excavated from the canals to assure food supply for the plant-eating animals without hampering the water flow and to reduce evaporation. 4. Studying the fish productivity and increasing fish production.

SUPPORTED BY Florida State Government - Tallahassee

2.0131, EXPERIMENTAL INTRODUCTION OF EXOTIC FRESHWATER FISHES

R.N. YOSHIDA, State Div. of Fish & Game, *Honolulu, Hawaii* 96813

Objectives: 1. To introduce selected species of fresh water fish into the State. 2. To ascertain whether or not these fishes will reproduce and thrive under local conditions. 3. To determine the feasibility of utilizing certain species of fish for the control of undesirable aquatic vegetation.

Procedure: Surveillance of the effects of some 2,000 grass carp (Ctenopharyngodon idellus) finerlings released into the Waiakea PFA will be continued. The fingerlings were imported from Taiwan and released into this isolated body of water in an experimental attempt to cope with serious aquatic vegetation problems. Surveillance will be primarily visual, in conjunction with work on artificial fish shelters in the same area.

Efforts will be continued toward finalizing cooperative agreements with two landowners on Maui, to establish two new public fishing areas. Should these efforts be successful, experimental stocking with rainbow trout, using eggs imported from the mainland and processed at the Keehi Fisheries Station, will be carried out.

The search for additional desirable species for introduction will be continued. Whenever new fish are introduced, first consideration will be given to rearing of the fish in hatchery ponds, laboratory tanks or brood ponds until such time that the fish reproduce and the young can be distributed into selected bodies of water for evaluation. This procedure may be modified and direct releases may be made into streams or other bodies of water if space limitations become a problem or if the biological characteristics of the fish make immediate release advisable. Periodic follow-up checks will be conducted to keep track of the status of all releases.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0132, AQUATIC WEED SUPPRESSION AND CONTROL IN LARGE CANALS

D.W. BOYLE, U.S. Dept. of the Interior, Bureau of Reclamation, *Boise, Idaho*

The project is carried out to find methods and materials which will control or suppress aquatic weeds in large canals. Herbicides found promising in laboratory and other field studies are tested in delivery channels to find the least quantity effective in suppressing aquatic growth to tolerable levels. The three major aspects studied are: ecology of the aquatic environment in the field, field tests on project channels to learn the most effective materials at the lowest rates which will suppress aquatic weeds, and studies and competitive aquatic plant species to suppress growth of weedy species with and without the aid of chemicals.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0133, A CRITICAL TEST OF METHODS FOR ISOLATION OF VIRUSES FOR USE IN CONTROL OF NUISANCE ALGAE

H.N. GUTTMAN, Univ. of Illinois, School of Liberal Arts, *Chicago, Illinois* 60680

First tests by others have revealed the presence of a very few types of algae viruses which are now being tested as potential controllers of nuisance algae. The methods for virus selection selects against isolation of the rarer viruses which may be more valuable because of different host specificity, etc.

We are therefore critically evaluating two methods for isolation and purification of algal viruses to determine whether the commonly used method inadvertently selected out for the few most abundant viruses and against the rarer viruses which may have more eventual value as algal controllers.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0134, GROWTH REGULATORS AND MINERAL NUTRITION IN AQUATIC PLANT CONTROL

H.J. PRESLEY, Univ. of Illinois, Graduate School, *Chicago, Illinois* 60680

An investigation will be made of the effect of an herbicide, retardant, and gibberellic acid on the growth of the nuisance hydrophyte, Elodea.

An assessment will be made of the modification of nutrient uptake and nutritional disarrangements within the plant resulting from application of these growth-control substances. Nutrients to be considered include phosphorous, calcium, amino acids, and total protein within the plant.

2. AQUATIC PEST CONTROL

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0135, NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA

V.P. RAO, Comm. Inst. of Biolog. Control, *Bangalore, India* (480A7ENT85)

OBJECTIVE: Obtain and analyze information about the biotic agents associated with witchweed, nutsedge, and several aquatic weeds in India, determine the host specificity of each agent, and evaluate the potential of each agent for use in biological control of the weed.

APPROACH: A list of potential biological control agents, principally insects and mites, will be prepared from existing records and from field surveys to be conducted on these plants in their native habitats. The host specificity of each agent will be determined from direct field and laboratory observations and experiments. Species that meet host-specificity requirements will be studied in detail to provide information on their life histories, ecological requirements, and natural enemies. The effect of the agent on its host will be noted, with emphasis on the time of attack with respect to stage of plant development. The potential of each agent for use in biological control will be assessed. All material will be identified, cataloged, and preserved, and examples will be furnished to the Entomology Research Division, Washington.

PROGRESS: The two 'forms' of the noctuid Eulocastra attacking witchweed were found to be ecologically isolated according to their feeding sites. Morphological and taxonomic studies indicate two species are involved. Neither 'form' has fed on any scrophulariaceous plant so far tested, other than Striga. Heavy infections of the fungi Alternaria and Cercospora spp. were noted on witchweed. Specificity tests were conducted on the flea beetle Altica caerulea and the weevil Nanophyes sp. found attacking water primrose. Altica fed on several of the ornamental plants of the family Onagraceae tested, while Nanophyes sp. did not. Two species of Psara (Lep., Pyralidae) were found attacking alligatorweed, and several species of Nymphula spp. were found damaging Hydrilla Nymphaea, Nymphoides, and Potamogeton. None of the 53 plants tested were susceptible to the water hyacinth fungus Alternaria n. sp.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0136, THE USE OF FLAME FOR CONTROLLING WEEDS AND BRUSH

R.M. LIEN, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01256)

OBJECTIVE: Study flame weed control in tillage practices where present control methods are inadequate. Evaluate the effectiveness of flaming for control of weeds and brush on ditch banks. Determine cost input factors for determining economic feasibility.

APPROACH: Field studies will be conducted on minimum tillage plots to determine effectiveness of flame weed control in those practices (rough and trashy) where present weed control methods are inadequate or costly. Sod planting plots will be flamed to study retardation of grass growth to facilitate corn growth. Three ditch locations over the state will be selected in cooperation with the county surveyor and flamed once during the season when brush is in full foliage (June) to determine the heat tolerance of various wood species operational procedures and overall effectiveness as compared to other methods. Cost data will be determined on all operations.

PROGRESS: Investigations were limited to the further study of weed control on ditch banks. In 1967, a demonstration area using flame for brush and weed control on ditch banks was established in Clinton County. A reflame of this area was conducted in 1969 to clean up the new regrowth that was appearing. The first flaming gave satisfactory control. The reflame is a maintenance procedure. Kill results will not be determined until the 1970 growing season.

SUPPORTED BY Indiana State Government

2.0137, DETERMINATION OF THE EFFECTS OF A FERTILIZER-INDUCED PLANKTON TURBIDITY, SUPPLEMENTED BY HERBICIDES, ON SUBMERGED AQUATIC PLANTS

R.E. SCHOONOVER, State Forest. Fish & Game Com., *Pratt, Kansas* 67124

Objective: To develop methods for controlling aquatic vegetation.

Procedures: 1. Standard survey procedures will be used in determining pertinent physical, chemical, and biological conditions of lakes and smaller impoundments prior to initiating experimental aquatic plant control projects, and will be continued periodically while the projects are in progress. Particular emphasis will be given to determining the principal species of aquatic plants, their distribution and abundance, prior to beginning control measures and periodically during each segment while control measures are being applied. 2. The control measure, or combination of control measures, consisting of fertilization, herbicides, chemicals, and other materials, as stipulated in the Job Description will be applied to certain waters to determine their effectiveness against the specific plants. Other lakes or areas will be maintained as control waters for comparison with these test lakes. 3. Detailed studies and observations will be made to determine the effects of the experimental measure on the aquatic vegetation and the degree of control achieved.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0138, A STUDY OF INHIBITORY COMPOUNDS PRODUCED BY FRESH-WATER ALGAE

D.O. HARRIS, Univ. of Kentucky, Water Resources Institute, *Lexington, Kentucky* 40506

The purpose of this study is to examine the biological and chemical properties of inhibitory compounds produced by fresh-water algae (Volvocales). Past experiments by the author have shown a substance produced by Platydorina caudata to be: heat labile, non-dialyzable, dilutable several times with no loss in activity, specific for Platydorina, unstable at both acid and base conditions and unaffected by short periods of freezing and exposure to bacterial contamination. Studies here will be expanded to include Sephadex, DEAE cellulose, proteolytic enzymes, electrophoresis, etc. in an attempt to isolate and completely characterize these substances.

The study here will be three-fold in nature: (1) a study of substances which are auto-inhibitory in nature, (2) an examination of substances which are not specific for any one organism but affect a wide range of both animals and plants, and (3) a characterization of the substances and an attempt to learn how they work in order to gain insight as to a method for controlling non-desirous algal blooms. Perhaps this line of investigation will eventually provide clues to a method of controlling algae in water supplies, etc.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0139, AQUATIC WEED CONTROL BY POND FISHES

J.W. AVAULT, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01279)

OBJECTIVE: Determine weed control effectiveness of various species of herbivorous fish; stocking procedures for these fish; effect of stocked fish on established fish populations; economics feasibility of herbivorous fish use.

APPROACH: Promising fish species will be field-tested in small pools and in earthen ponds. New species will be evaluated. Various rates and sizes of fish will be tested for weed control. Effect of herbivorous fish on fish populations will be determined by seine and fishing. Cost and benefit records will be analyzed.

PROGRESS: The grass carp is the most efficient fish for controlling aquatic weeds in ponds. If we use this fish for controlling weeds, we must learn to culture it. Grass carp fry were successfully grown to fingerling size in the laboratory. Initially they were fed brine shrimp. When one month old, they were fed a commercial fish feed. Tilapia are very efficient for controlling filamentous algae in ponds. The most serious drawback to their use is that they die in the winter because they are a tropical fish. We were successful in overwintering large numbers of tilapia in ponds by flowing in warm water from an artesian well.

SUPPORTED BY Louisiana State Government - Baton Rouge

2.0140, USE OF CHEMICALS ON RICE

J.B. BAKER, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01383)

PROGRESS: Combination of various pre-emergence or post-emergence treatments with propanil failed to give yield increases over propanil alone. None of the pre-emergence treatments gave yields superior to propanil and only CP-53619 at 1-1/2 lb/A as a delayed pre-emergence or G-13638 at 1-1/2 lb/A as a delayed pre-emergence gave yields equal to propanil. Pre-emergence treatment with 4 lb/A CP-53619 or 0.75 and 1.5 lb/A RP-17623 gave yields less than the untreated check. Other pre- emergence treatments yielded the same as the untreated check.

SUPPORTED BY Louisiana State Government - Baton Rouge

2.0141, FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS

J.B. BAKER, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01495)

OBJECTIVE: Study the effect of various factors on germination, growth, and development of selected aquatic weeds of rice fields.

APPROACH: Initial studies of factors influencing germination will be made on seed collected from the field. An attempt will be made to grow the plants under controlled conditions for future seed supplies. Following studies on germination, the effects of environmental factors on growth and development will be investigated. Environmental factors to be emphasized in studies are temperature, oxygen tension, and light (intensity, duration and quality). These factors will be monitored in the field to see if a correlation can be found between field observations and laboratory results.

PROGRESS: Seeds of Heteranthera limosa, Ammania coccinea, Bacopa rotundifolia, and Sphenoclea zeylandi were collected from natural infestations of these weeds at the Rice Experiment Station. Preliminary studies indicate that germination of the latter three is very low. The seed of Heteranthera limosa have a high germination under proper conditions. A detailed study of the light requirements for germination of Heteranthera limosa was begun. Preliminary results indicate duration of light treatment is more important than intensity, and the red light is stimulatory while far-red is inhibitory.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0142, FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION

B.A. BATEMAN, Louisiana State University Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01008)

OBJECTIVE: For Idlewild Lake management, to determine effects of fertilization and chemical weed control on production of bass and sunfish. For Idlewild game management, to make a census of wildlife, to study forest game production as related to tree species composition and abundance, to produce turkey and quail food on plots, and to determine wildlife values of native vegetation.

APPROACH: The lake will be fertilized. Periodic checks will be made on fish production. Weed control will be initiated. Game foods will be type-mapped and a game census will be made. Food plots will be established. Prescribed fire will be used to improve game habitat. Utilization by game animals of various foods produced on the area will be measured.

PROGRESS: The lake at Idlewild was very low - - down over 12 ft., early in 1969. Heavy rains beginning in February raised the water level to within 3 ft. of the top of the overflow. Throughout the year, the water level remained within 2 ft. of the high point reached. Drastic fluctuations in water level have controlled aquatic vegetation. Deer populations have remained low in the timbered areas based on: 1. deer seen 2. tracks a3. browse observed on the more palatable browse species. A double fence was erected in 2 food plots to control deer. The inner fence was made of 2-inch mesh chicken wire, 5 ft. high. The outer fence - - placed 5 ft. from the inner one - - was made by using 4 strands of barbwire with a total height of 5 ft. Soybeans were planted before the fences were built and there were beans on all four sides. All beans were eaten outside the fence, but the deer did not go over the fence. Rabbits - - based on sight records during the spring - - were at near peak numbers. The food plots were planted to wheat and white clover in the fall. Feeding signs show turkey, rabbit and deer are using this food. Some 25 or 26 turkey were known to be on Idlewild during the fall. Fires east of the creek during the last 2 winters have greatly reduced hardwood brush in the pine stands and increased seed- bearing annuals and perennials, especially legumes.

SUPPORTED BY Louisiana State Government - Baton Rouge

2.0143, FOREST AND FARM GAME HABITAT; FISH POND

B.A. BATEMAN, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB00427)

OBJECTIVE: Study changes in wildlife and fish habitat produced by various cultural practices.

APPROACH: Key farms in Louisiana will be selected for detailed studies of habitat changes. The effects on controlled burning on food available for quail, turkey, and deer will be studied. Development of forest undestory under various treatments such as burning discing, fertilization, and planting will be observed. Several different herbicides will be tested for weed control in fish ponds.

PROGRESS: The farm as a game habitat continues to deteriorate as farming practices become more intensive and efficient. Detrimental effects include; 1. Eradication of turn rows, ditches, unused corner and fence rows. 2. Clean cultivation-use of herbicides. 3. Multiple crops whereby new crops may be planted in both spring and fall. Winter crops of rye grass, small grains, vetch, and clovers add food for certain species; however, these species are usually in low numbers due to the overall yearly farming program. Burning for the improvement of the habitat for bobwhite, rabbit and turkey on the more moist sites must be done annually to give the highest benefits. Dense young pine stands from about 6 to 20 years of age produce very little game food. A combination of fire and thinning create a much better habitat as soon as such stands will produce merchantable products. An almost complete acorn failure during 1969 has caused squirrel to scatter over wide areas in search of food. Such acorn failures are usually followed by low production during the following spring breeding season. In the overcup- rock elm areas of the Delta owned by the Wild Life and Fisheries Commission, a management plan has been developed which calls for well interspersed forty-acre blocks to be clear cut at 5-year intervals. Some planting of selected species has also been recommended.

SUPPORTED BY Louisiana State Government - Baton Rouge

2.0144, INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA

A.D. OLIVER, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (00ENTJ02261901GR)

OBJECTIVE: Survey insects and related arthropods that feed on aquatic weeds of foreign origin in Louisiana; preserve and identify representative examples; gather and record data on their biologies; and evaluate their potential in weed control.

APPROACH: Surveys on alligatorweed, waterhyacinth, and parrot's feather will be conducted throughout the year in major ecological areas of Louisiana. Specimens will be collected, prepared, and identified by recognized taxonomists in Louisiana and Washington, D.C. Biological studies in the field and in the laboratory, with emphasis on seasonal occurrence, number of generations per year, and duration of life history stages, will be conducted. Specimens of developmental stages, and notes on conditions under which they were found, will be preserved.

PROGRESS: Surveys and examinations in the Bonne Carre and Atchafalaya spillways revealed 0-20% of water hyacinth infested with Arzama densa Walker and localized areas of alligatorweed completely defoliated by the southern garden webworm. A weevil, Sphenophorus sp., was found feeding on water hyacinth, primarily where back waters had receded. Generally, these aquatic weeds were found to be relatively free of insects that might cause significant reduction of the weed populations. During surveys, vast expanses of weeds were examined and found free of biotic factors that could alleviate problems of congested lakes, streams, and canals.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0145, INSECTS ASSOCIATED WITH AQUATIC WEED PESTS OF FOREIGN ORIGIN

A.D. OLIVER, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01401)

PROGRESS: Surveys for insects infesting water hyacinth were made in the Brown's Bayou, Bristol Bayou, Kings Ditch, upper Grand River flats and Bonne Carre Spillway. Arzama densa was the only insect found to use water hyacinth and primary host. One to 11% of weeds were or had been infested in localized areas. Examination of alligator weeds for insect infestations were made at Alabama Bayou, Catfish Bayou and various drainage canals in Iberville Parish. No species was found to use this weed as a primary host. In August, September and early October the southern garden webworm defoliated patches of this weed in St. Tammany and Washington Parishes. No insect species were found which showed promise for use in the biological of this weed.

SUPPORTED BY Louisiana State Government - Baton Rouge

2.0146, EXPANDED AQUATIC PLANT CONTROL PROJECT

J.A. FORET, Univ. of Southwestern La., School of Agriculture, *Lafayette, Louisiana* 70501

Biological study of the vegetation to determine what factors prevent translocation of herbicides. Development of a non-toxic spray which will destroy alligatorweed either by foliage application or underwater attack on the submerged portions of the weed. Develop means of increasing the translocation of herbicides throughout the entire plant to include the buds located at the nodes of the plant from which secondary growth springs. Evaluation of water conditions as they apply to the plant. Examination of various products with respect to their possible use as a means for destroying the past growth. Conduct of field tests under actual growing conditions to determine the effects of various materials on the vegetation.

To date, the research workers at the University of Southwestern Louisiana have found that there is translocation throughout the plant from the leaf to the root; that the buds located at the nodes of the plant appear to be protected from the chemical which otherwise moves through the plant and are the source of regrowth under certain favorable conditions; discovery that certain materials when added to known herbicides appear to provide a means of penetrating into the buds and lead to their ultimate destruction. This latter development is under intensive study at the present time and will be reported on in the future as data are assembled. Herbicide treatment seems to be more effective when absorption is through the root system.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0147, AQUATIC PLANT CONTROL - EQUIPMENT FOR MECHANICAL AND CHEMICAL DESTRUCTION

W.E. WUDERLICH, U.S. Army, Engineer District, *New Orleans, Louisiana* 70160

Short description of machinery that has been used in the past for aquatic vegetation destruction in Louisiana.

Development of special devices used in application of chemicals on aquatic vegetation. Description and sketches of these devices.

Examination of the equipment available on the commercial market for use in this kind of work and listing of those that appeared to be satisfactory for various types of jobs.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0148, INFLUENCE OF PESTICIDES & OTHER HYDROCARBONS ON GROWTH OF EURYTOLERANT MICROALGAE

R.L. VADAS, Univ. of Maine, Agricultural Experiment Sta., *Orono, Maine* 04473 (ME00245)

OBJECTIVE: Determine growth rates of unicellular algae at several concentrations of pesticides under varying temperature, pH and salinity regimes. Determine if eurytolerant microalgae are more tolerant of pesticides than similar species with narrow tolerances. Determine if eurytolerant algae accumulate pesticides and other chlorinated hydrocarbons.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0149, ALGAE CONTROL BY ARTIFICIAL MIXING IN LAKE COCHITUATE

UNKNOWN, Jason M. Cortell & Associate, *Natick, Massachusetts*

It is the general objective of this project to (1) demonstrate a methodology for solving lake eutrophication problems by determining the amount of sampling, river gaging, nutrient source studies, algal counts, species identification, etc. necessary to deveop effective long-term control of algal growths, and, (2) to demonstrate the effects of lake destratification by artificial mixing.

SUPPORTED BY Massachusetts State Government

2.0150, THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY

G.S. HOWELL, Michigan State University, School of Agriculture, *East Lansing, Michigan* 48823

The proposed research would involve a two-fold study of the effect of herbicides commonly applied to horticultural crops on the ecology of microflora in streams adjacent to the orchard or field. The laboratory phase of the research includes application of herbicides to water samples collected from a stream. Subsequently, measurements of the growth, development and population dynamics of the natural microflora will be made. Growth will be measured via dry weight determinations, quantitative estimation of chlorophyll A, and measurement of photosynthesis and respiration via illuminated manometric techniques. The effect of herbicide application on algal population dynamics will also be measured via per cent estimation of population components.

The field phase of the research will involve the collection of water samples from streams prior to, during, and after the stream passes an orchard or field. Oceana County, in western Michigan, is proposed as the site for the field work based on two criteria: 1) it is an important fruit production area, using large amounts of herbicides, 2) it has a stream offering two methods sampling. Consecutive sampling in the same stream and comparison sampling between two independent watersheds. One of which drains a fruit area while the other drains a non-cropped area.

Water samples will be collected and concentrated by flash evaporation and analyzed for the following parameters: a. herbicide residues via chloroform extraction and measurement by gas-liquid chromatography. b. total N, by micro-kjeldahl procedures. c. Nitrate and other nutrient elements of spectrographic analysis. d. total dry matter.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0151, DEVELOP A SELECTIVE ALGACIDE TO CONTROL NUISANCE ALGAL GROWTH

W.F. MCILHENNY, Dow Chemical Company, *Midland, Michigan* 48640 (14-12-814)

Description. To develop a chemical which will control the growth of bluegreen algae economically and which will have a minimum impact on other life in the aquatic environment. Such an acceptable algaecide must have the following properties: (1) Safety to non-target organisms; (2) high degree of specificity; (3) economical; (4) safety to applicators; and (5) non-persistent.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.0152, ALLEVIATION OF LAKE POLLUTION BY UTILIZATION OF AQUATIC PLANTS FOR NUTRITIONAL, MEDICINAL OR INDUSTRIAL PURPOSES

E.J. STABA, Univ. of Minnesota, School of Pharmacy, *Minneapolis, Minnesota* 55455

The objective of the research is to find a nutritional, medicinal or industrial use for the unwanted aquatic plants in lake shoreline areas. It is possible that some aquatic plants may contain industrially useful gums-mucilages or new useful antimicrobial, anticoagulant, or antineoplastic therapeutic principles. Aquatic plants will be collected from various lakes in Minnesota and identified, processed and phytochemically screened for useful compounds. Microbial and animal studies will be conducted. If a good industrial, medicinal or nutrional use for aquatic plants can be discovered, the results of the research could provide an economic incentive for aquatic plant collection and control. The successful completion of the project might significantly assist the state and Nation in partially solving their lake pollution problems.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0153, EVALUATION OF POND CONDITIONS FOLLOWING FERTILIZATION

J. DOBIE, State Div. of Game & Fish, *Saint Paul, Minnesota* 55101

The objective is to learn how to operate walleye rearing ponds which have developed excessive aquatic vegetation after organic fertilization.

Information was obtained in project F-13-R-1-to 12 on bottom fauna, plankton and vegetation that can be produced by fertilization. Organic fertilizers, while effective in producing populations of zooplankton and bottom fauna, also produce undesirable, dense stands of aquatic vegetation of heavy mats of filmentous algae. Before organic fertilizers can be extensively used in production ponds that are too wet for vegetation control through greenfallowing, information is needed on the reaction of walleye fingerlings to beds of vegetation and practical methods of controlling vegetation in ponds.

Procedure: Determine which several herbicides available commercially are satisfactory for control of aquatic vegetation while ponds are occupied by fingerling walleyes. 2. To control algae through bonding or precipitation of soluble iron.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0154, CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI

J.R. WHITLEY, State Dept. of Conserv., *Columbia, Missouri* 65201

Description: The relationships of dense aquatic weed growths in Lake Taneycomo to nutrient inflow from Table Rock Lake and nutrient inflow from local sources will be determined. The influences of water temperature, water clarity, water current and bottom substrate on growth of aquatic plants will be measured.

Safe and effective methods of chemical weed control will be demonstrated in cold flowing water.

A program of water sampling and chemical analysis will be initiated to measure the principal sources of plant nutrients in the Lake. Weed beds will be mapped and all species of rooted aquatic plants will be identified. Detailed records will be made of water temperature fluctuations related to power production. Three aquatic herbicides will be applied at several concentrations to a large number of demonstration plots. Additional weed plots will be sprayed during a 24-hour draw-down in midsummer.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.0155, CONTROL OF UNDESIRABLE AQUATIC VEGETATION

J.R. WHITLEY, State Dept. of Conserv., *Jefferson City, Missouri* 65102

Objectives: To develop effective methods of controlling undesirable aquatic vegetation and to study the biological and chemical effects of herbicides.

Procedures: Problems associated with aquatic vegetation control will be investigated as follows: 1. Effects of diuron (Karmex) treatments on ponds (Job No. 1) 2. Control of Eurasian milfoil (Job No. 2)

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0156, CONTROL OF EURASIAN MILFOIL

J.R. WHITLEY, State Dept. of Conserv., *Jefferson City, Missouri* 65102

Objectives: To determine the best method of controlling Eurasian Milfoil in Lake of the Ozarks.

Procedures: Open water test plots will be established in heavy stands of milfoil to determine the optimum application rate of 2,4-D compounds which will give satisfactory control.

An effort will be made to measure the increase in area affected by milfoil in 1969. Only a few acres were obvious in Lake of the Ozarks in 1967, and approximately 300 acres were present in 1968.

Efforts will be directed towards finding a biological control method for Eurasian Milfoil.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0157, CONTROL AND UTILIZATION OF AQUATIC PLANTS

J.R. WHITLEY, State Dept. of Conserv., *Jefferson City, Missouri* 65102

Objective: To identify Missouri aquatic plants, plot their distribution, classify them as desirable or undesirable in fishing ponds and lakes and develop methods of control for undesirable species.

Procedures: Prepare an aquatic plant manual for Missouri which will include color and black and white photographs for identification and a section on the beneficial or problem characteristics of each species as related to fishing ponds and lakes. Distribution patterns will be determined from plant collections made by regional fishery biologists and other specialists and from existing records in the literature and in the University of Missouri herbarium.

Some desirable aquatic plants seem to have the ability to restrict the growth of other nearby plants. Desirable aquatic plants will be introduced into existing populations of undesirable plants by transplanting growing plants, rootstocks or seed. A series of new ponds or lakes which are devoid of vegetation will be planted with desirable plants as soon as they fill to determine if undesirable populations can be prevented from developing.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0158, CONTROL OF CANADA THISTLE AND WATER WEEDS

J.M. HODGSON, Montana State University, Agricultural Experiment Sta., *Bozeman, Montana* 59715

The life cycle and growth habits of Canada Thistle and Reed canary grass are being studied. Chemicals for the control of these weeds are being evaluated at the several locations on noncropland and the effects of differing climatic conditions are being observed. Selective treatments for control of Reed canary grass in Kentucky bluegrass and other grass species are made at Bozeman and Huntley, Montana. Promising herbicides for control of submersed pondweeds in irrigation systems are being evaluated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0159, STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS

J.M. HODGSON, Montana State University, School of Engineering, *Bozeman, Montana* 59715

The life cycle and growth habits of Canada thistle and Reed canary grass are being studied and promising herbicides for control of submersed pondweeds in irrigation systems are being evaluated.

Evaluation of gravity irrigation efficiency factors for border dikes and furrow irrigation and application of the developed empirical equation as affecting Huntley Project irrigation system. Power requirement changes resulting from application of various levels of calcium. Reclamation of alkali and saline soils.

Salt and water movement in a salt garden on the Huntley Project is being studied. Specific effects of relative concentrations of Na ion and Mg ion on plants are being observed. The returns from irrigated pastures on saline soils in the Huntley Project are being determined.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0160, CONTROL OF WEEDS IN AQUATIC AND NON-CROP AREAS IN THE UPPER MISSOURI RIVER BASIN

J.M. HODGSON, Montana State University, U.S.D.A. Crops Research Div., *Bozeman, Montana* 59715 (0710-02-06)

OBJECTIVE: Develop information on the control of important aquatic and bank weeds in irrigation canals, reservoirs, and farm ponds and other non-crop areas. Develop improved equipment and techniques for evaluation of control measures and for weed control.

APPROACH: Conduct herbicide evaluation trials for control of aquatic and bank weeds including greenhouse and field applications. Characterize the possible occurrence and level of pollution of irrigation waters and subsequently irrigated crops by herbicides following weed control treatments. Gather ecological information on important weeds, evaluate competitiveness of desirable ditchbank species and determine their ability to inhibit weeds under various schemes of management. Evaluate various biological agents for control of weeds.

PROGRESS: The lipids present on the leaf surfaces of Canada thistles were sampled by hexane-ether extraction. The amount of lipid present was significantly affected by field site. Plants from the site of highest humidity and lowest mean temperatures produced the least lipids on the leaves. Different ecotypes of Canada thistle also yielded significantly different amounts of lipid as an average of all locations. These ecotypes also differed significantly in leaf weight per square centimeter, however, there was no correlation between leaf weight and lipid yield. There was a significant positive correlation of amount of lipid present on the leaves and response to 2,4-D at the Bozeman site which was the only site for which 2,4-D data was available. Picloram and dicamba gave effective control of Canada thistle and were not improved in toxicity by combining them with 2,4-D or 2,4-dichloro-6-(0-chloroanilino)-s-triazine. Irrigation water carrying known concentrations of the herbicide fenac had no effect on yield of alfalfa, sweet corn, sugarbeets or sweet corn with rates of fenac up to .9 lb/A. Spring wheat yield in these treatments was reduced in yield at the .9 lb/A rate but was not affected by lighter rates that were included.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

2.0161, RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES

J.M. HODGSON, Montana State University, Agricultural Experiment Sta., *Bozeman, Montana* 59715 (MONB00333)

OBJECTIVE: Determine effects of repetitive application or persistent pollutional levels of herbicides on plant communities.

APPROACH: The purpose is to develop information on the influence of herbicides on ditchbank ecosystems. An attempt will be made to identify factors necessary to encourage desirable low-growing vegetation on ditchbanks and determine the possible contamination of irrigation water resulting from herbicidal treatments of ditchbanks ecosytems. Potential selective herbicides such as dalapon, amitrole, TCA, and dicamba will be applied annually to weed infestations on ditchbanks or to field-grown plantings of species from ditchbank ecosystems. Stand composition of plants before and after treatments will be evaluated by the line transect or quadrat count procedures. Treatments will be designed to encourage establishment low-growing grass species and control or eliminate tall-growing broadleaved or grass species that interfere with water delivery. Ditch water and soil samples will be analyzed for possible contamination.

PROGRESS: In this initial period plant materials have been established in the field and a review of the literature concerning the approach to this problem has been completed. The first data from this experiment will be obtained in the 1970 field growing season.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0162, BIOLOGY AND CONTROL OF AQUATIC WEEDS

D.N. RIEMER, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00144)

OBJECTIVE: Determine incidence and distribution of various aquatic weeds in relation to varying ecological conditions, natural and imposed; life histories and ecological requirements of aquatic weeds, especially their control by herbicides or by other manipulative practices; and behavior of herbicides in an aquatic environment and to determine their effectiveness against various species of aquatic plants. Develop safe and economic control measures.

APPROACH: Life histories and ecological requirements of important aquatic weed species and modes of reproduction under varying environmental conditions will be studied in the laboratory and in the field. Activity, retention, movement and degradation of weed control chemicals in plants, water and substrate will be studied. Information obtained will be used in the development of safe, effective and economic methods for the control of aquatic weeds.

PROGRESS: Spatterdock (Nuphar advena) is difficult to control with herbicides because of rapid regrowth from the large rhizome. Experiments were conducted to determine the effects of adding an experimental growth regulator to 2, 4-D and applying the combination to spatterdock. At the rates used, the growth regulator caused more rapid and extensive regrowth than that which occurred in plots treated with 2,4-D alone. Field studies with common reed (Phragmites communis) indicate that two half-doses of the herbicide dalapon may be more effective than the same amount of herbicide applied as a single dose. This response is especially noticeable the year following treatment. Arrowarum (Peltandra virginica) seeds will not tolerate freezing and will not germinate until the pericarps have been removed. Studies are underway to investigate the nitrification of dried aquatic weed tissues when added to soil. Some species nitrify well while other species nitrify poorly despite relatively high nitrogen contents in the tissues. Samples of bottom mud collected from ponds with a known history of copper sulfate treatment. These samples will be analyzed to determine how much copper is in them and a known of how tightly it is bound to the soil.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0163, WATERLEVEL MANAGEMENT ON IMPOUNDMENTS OF LOW QUALITY SOILS

F.M. TOURINE, State Div. of Fi. Gm. & Shfsh., *Trenton, New Jersey* 08625

Objectives: To study the effects of drawdown and fertilization on smartweed Polygonum hydropiperoides.

Procedures: Previously estalished plots at Success Lake will be used to continue the study of the fertilizer requirements of smartweed and the effects of drawdown. This work will be carried out in cooperation with Dr. Stephen Toth. Plant and seed analysis will be conducted in the Rutgers Lab. by Dr. Toth. Where necessary, herbicides will be employed to control undesireable plant growth.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0164, BIOLOGICAL CONTROL - TAMARISK AND OTHER PHREATOPHYTES

J.G. WATTS, New Mexico State University, Graduate School, *Las Cruces, New Mexico* 88001

The purpose of this study is to determine how the growth of tamarisk and other phreatophytic non-beneficial water loving plants can be controlled biologically. Since these plants are reportedly using enormous quantities of water and the costs of control by herbicides and mechanical methods are relatively high, a study to determine biological control measures is justified.

A Contract No. 14-06-500-1517, dated May 16, 1968, was executed between the Bureau of Reclamation and New Mexico State University to provide for the study. Approximately five years are expected to be required for this study.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

2.0165, EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS

S. AARONSON, City University of New York, School of Liberal Arts, *Flushing, New York* 11367

The secretion by algae of large quantities of cellular metabolites into the environment will be examined. Two principal methods will be employed to evaluate the accumulation of metabolites and secretory ability: (1) The olive-green chrysomonad, 'Ochromonas danica', will serve as a model organism for determining the conditions of growth and stress which lead to the accumulation of micromolecules (amino acids, nucleic acid constituents, sugars, etc.), macromolecules (proteins, polysaccharides, enzymes, RNA, DNA), and membranous vesicles and (2) Inhibitory concentrations of metabolite analogs will be used to select (a) for algae which can synthesize large quantities of target metabolite and (b) against specific algal groups.

SUPPORTED BY U.S. National Science Foundation

2.0166, FACTORS CONTROLLING THE GROWTH OF THE AQUATIC WEED SALVINIA

J.J. GAUDET, State University of New York, School of Arts, *Stony Brook, New York* 11790

A floating aquatic weed, 'Salvinia', has been rapidly spreading into more and more areas throughout the tropics. Although the plant originates in South America, it is not a problem in that country. In fact, of the seven native species, six have restricted distributions which suggests some natural factors keep 'Salvinia' in check in South America. By studying the growth of all of the species in sterile culture under standard conditions and in nature it is hoped that two questions can be resolved: 1) what factors are present in nature which restrict the spread of the plant? and 2) which of the seven species are potential troublesome aquatic weeds. In addition, an attempt will be made to determine whether or not various natural and synthetic nitrogenous compounds might be effective in controlling the growth of the plant.

SUPPORTED BY U.S. National Science Foundation

2.0167, INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED

C.E. BOND, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00773)

OBJECTIVE: Determine means of controlling Brazilian waterweed and other nuisance aquatic plants; assess impact of control measures on recreational, industrial and domestic uses of the bodies of water involved.

APPROACH: Screen known and potential herbicides for activity against problem aquatic plants. Assess toxicity of herbicides to fish and fish food organisms. Test selected herbicides in field. Assess effect upon environment. Investigate biological, mechanical and other means of control.

PROGRESS: Screening tests were conducted on 118 herbicides. None of these were found to be as effective as chemicals presently in use. Tests were begun on the relationship of the toxicity of certain herbicides to temperature and light quality. 36 tank studies were conducted on Elodea densa. Seven chemicals or combinations at varying concentrations, were used in each of two trials. The first trial was begun in mid July, the second in mid September. Two chemicals gave excellent control in the summer trial but fall trials were not effective possibly because of the lower fall temperature. The 1968 field trials in Ten-mile Lake were re-evaluated. The plots which were treated with diquat initially and retreated with dichlobenil remained essentially weed-free during 1969. Further herbicides applications were made which will be observed in 1970. 20 field plots were established in Siltcoos Lake. Short term control was achieved. Further evaluations are scheduled in 1970 to determine long term effects.

SUPPORTED BY Oregon State Government - Salem

2.0168, EUTROPHICATION - EFFECT OF FLOW AUGMENTATION

A.F. BARTSCH, U.S. Environ. Protection Agcy., Office of Water Programs, *Corvallis, Oregon* 97330

The immediate objective is to determine the effect on algal bloom production when a nutrient-rich lake is flushed with nutrient-deficient water. Ultimate objective is to decrease or eliminate algal blooms in Moses Lake, Washington. One of three branches of the lake will be flushed with low-nutrient water while the others remain as controls. After flushing during August and September, 1968, a year of no water diversion will follow to permit determining persistence of improvement. This approach will evaluate flushing as a remedial tool and will indicate the periods of future water diversion needed to permanently prevent bloom formation. Principal parameters to be investigated are as follows: 1. Water current studies at selected sites and depths. 2. Water budget studies at selected sites and depths. 2. Water budget studies to determine extent and efficiency of flushing. 3. Turbidity measurements and suspended solids analysis. 4. Chemical and physical parameters to determine existence and character of thermal stratification and also environment for alage. 5. Qualitative and quantitative determination of algae, including measurements of phytoplankton pigments, biomass, and species diversity. 6. Chemical analyses and oxygen demand studies of bottom muds.

Basic data collection and analyses will be conducted cooperatively by FWPCA and University of Washington personnel. Other cooperators will be the Bureau of Reclamation and a citizens group in the city of Moses Lake, Washington.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.0169, EUTROPHICATION - EFFECT OF WEED HARVESTING

A.F. BARTSCH, U.S. Environ. Protection Agcy., Office of Water Programs, *Corvallis, Oregon* 97330

The principal objective is to evaluate aquatic vegetation harvesting as a means of effectively reducing algal nutrient availability. Harvesting and removal of aquatic vegetation is one of the potential control measures in combating eutrophication of bodies of water. It is a means of 'cropping off' part of the excess nutrients. Although weed harvesters have been used in the past, no really scientific investigations have accompanied their use. In cooperation with the Pelican River Watershed District, Minnesota, city of Detroit Lakes, and University of North Dakota the effectiveness of the procedure will be evaluated. Attempt will be made to answer such questions as: 1. What is the amount of nutrients actually removed from a lake by weed harvesting? 2. What happens to the energy flow of nutrients that originally went into the plant growth? 3. What is the pattern of regrowth of the vegetation after harvesting and do other species replace the original ones? 4. Does the phytoplankton population change after the higher aquatic plants are removed?

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.0170, EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS

A.F. BARTSCH, U.S. Environ. Protection Agcy., Office of Water Programs, *Corvallis, Oregon* 97330

The objective is to determine if living organisms can be found which will harvest nuisance algae through grazing, or reduce them through disease and parasitism. A literature review will be made to determine the prospects for success and to identify North American or other species as prospective candidates for grazing trials. Promising animals will be evaluated in the laboratory or field as appropriate.

It was the consensus of most scientists attending the recent International Eutrophication Symposium in Madison, Wisconsin that this is a potentially fruitful area of research. It was felt that a biological control measure for algae could be found if sufficient effort were expended. This has not been done to date.

Much of the effort in the F. Y. 1968 will be desk work to learn what has been done by other researchers and to determine who might be interested in doing work with grant research funds.

Other activities will include preliminary laboratory evaluation of grazer candidates.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.0171, EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL

A.F. BARTSCH, U.S. Environ. Protection Agcy., Office of Water Programs, *Corvallis, Oregon* 97330

The objective is to determine if algal production can be inhibited by preventing thermal stratification of a lake. Prior destratification experiments have sometimes decreased and other times increased primary production. Because of this seeming paradox, it is necessary to understand this phenomenon and to utilize it if possible, as a means of preventing algal bloom formations. If total algal growth can indeed be retarded by mixing, it is necessary to learn if a lake has to be turned over every year or at lesser or greater intervals to give permanent relief.

Principal areas of ivnvestigation will include: 1. Measurements of water movements at selected sites and depths in a lake. 2. Measurements of chemical and physical parameters that are of importance to algal growth. 3. Measurements of algal growth.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.0172, EUTROPHICATION - PILOT OPERATIONS

L.P. SEYB, U.S. Environ. Protection Agcy., Office of Water Programs, *Corvallis, Oregon* 97330

As laboratory scale techniques are found for the control of algae in lakes, methodology must be developed for the scale-up of these techniques to use in field trials. Techniques of systems analysis and economics will be used in shifting from small scale to full scale demonstrations. It is an objective to plan the groundwork for this development.

It is anticipated that an engineer will be employed during the last quarter of F. Y. 1968 to work with personnel assigned to sub projects in the eutrophication program.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.0173, NATURAL ENEMIES OF EURASIAN WATERMILFOIL IN PAKISTAN

M.A. GHANI, Comm. Inst. of Biolog. Control, *Rawalpindi, Pakistan* (480A17ENT13)

OBJECTIVE: Find and evaluate insects and other organisms that feed on or otherwise injure Eurasian watermilfoil in Pakistan, and study the life histories, ecological requirements, and degree of host specificity of species that show promise sufficient to warrant consideration for introduction into the United States.

APPROACH: Insects and other organisms associated with watermilfoil will be studied in several locations in East and West Pakistan throughout the year. Samples will be collected and identified. Species showing promise will be studied in detail. The studies will develop information on life history, ecological requirements, degree of host specificity, and on how the species can be best shipped to the United States for further studies that may be required prior to release.

PROGRESS: No progress reported this period (active project).

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2.0174, THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS

R. PATRICK, Acad. of Nat. Sci. of Phila., *Philadelphia, Pennsylvania* 19103

The purpose of this project is to determine if more favorable conditions for growth of species of algae which are a desirable food source can be provided by manipulating the trace nutrients. There are indications that by controlling concentrations of manganese the development of diatoms rather than some of the less desirable green and blue-green algae can be brought about.

In this proposed program of work we wish to study the effect of various concentrations of carbon dioxide, boron, vanadium, nickel, chromium, and selenium on the development of various kinds of algae under nutrient enriched conditions. The concentration of chemicals under test will be determined by analyses each day or more frequently if desirable. Temperature and pH will be continually monitored. Light exposure and day length will be determined. Each chamical will be studied under different conditions of temperature, day length, and pH. The algal communities will be examined each day and all predators other than microscopic ones will be removed. The microscopic ones will be examined as to algal species they are ingesting. Biomass of algae; diversity of algal populations; and structure of the diatom communities will be determined.

This work is being performed at the field station of the Limnology Department--the Stroud Water Research Center.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.0175, THE CRAYFISH (ORCONECTES CAUSEYI) AS A BIOLOGICAL CONTROL OF AQUATIC VEGETATION

L.F. THOMPSON, State Dept. of Game Fish & Pk., *Pierre, South Dakota* 57501

Objectives: To determine the feasibility of the Crayfish (Orconectes causeyi) as a biological control of aquatic vegetation in South Dakota.

Procedures: To determine the character of the ecosystem prior to the introduction of Orconectes causeyi it will be necessary to measure the following parameters: 1. Physical features of the lake by mapping; 2. Fish populations by netting; 3. Other species of crayfish and benthos; 4. Extent and types of aquatic vegetation throughout the summer; 5. Food habits of the fish by stomach sampling.

To determine the effects of the crayfish (Orconectes causeyi) on aquatic vegetation after they are introduced in the fall of 1969, the above mentioned parameters plus monitoring all life stages of the crayfish throughout the year will be necessary.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0176, WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA

W.T. FLINCHUM, Rice Pasture Res. & Ext. Ctr., *Beaumont, Texas* 77706 (TEX01216)

OBJECTIVE: Evaluate and compare commercially recognized chemical weed killers with cultural and mechanical weed control practices as related to growth, yields and quality of rice. Determine the place of chemical weed control methods in pasture management. Determine a practical method of controlling vegetation of levees, irrigation and drainage ditches, road sides and fence rows. The study of the life history of rice and the various weeds in order to apply the principles of weed control in rice and pastures in a more practical and economical manner.

APPROACH: Experiments will be conducted under approved statistical designs. Data will be taken on rice growth, maturity, quality and yield on the effectiveness of control of different weeds present in the test in both rice fields and pasture lands. Data will be recorded and analyzed. Greenhouse and preliminary small plot screening test will precede most field tests to obtain information on efficacy and selectivity.

PROGRESS: Numerous experimental compounds were included in the primary evaluation trials. These compounds were evaluated for their efficacy in the control of weeds and their selectivity to rice when seeded by two different methods. Five chemicals at various rates applied preemergence to drill and broadcast seeded rice were equal to or better than postemergence applications of propanil. Residue experiments have been concluded on propanil and the phenoxy herbicides and samples have been submitted for analysis in order that new labels may be written with established tolerance to comply with pesticide laws. KN(3) has been developed for the control of an aquatic weed (ducksalad) in rice, but suggested farmer use awaits label clearance. One experimental chemical applied preemergence has shown some promise in the control of dayflower.

SUPPORTED BY Texas State Government - Austin

2.0177, ALGACIDES FOR USE IN WATER RECLAMATION AND REUSE SYSTEMS

B.D. COMBS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Longview, Washington* 98632

An algacide is needed for use in water reclamation and reuse systems which will not harm the nitrifying bacterial culture in the filter beds. Potential algacides will be tested in model water reclamation and reuse systems to determine effectiveness, treatment level, and frequency of treatment required. When suitable algacides are found from the model experiments, large-scale tests will be conducted in a production system.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0178, CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST

V.F. BRUNS, Irrigation Ag. Res. & Ex. Ctr., *Prosser, Washington* (0710-02-08)

OBJECTIVE: Develop more effective, safe, and economical methods for controlling weeds in aquatic and noncrop areas. Determine effect of herbicides in irrigation water on crops. Determine fate of herbicides in aquatic environments and in crops irrigated with treated water. Determine influence of ecological and physiological factors in control of weeds in aquatic and noncrop areas.

APPROACH: Evaluate chemical, mechanical, and biological methods of weed control. Treat selected canals and lakes with herbicides, determine effects on aquatic biota, and analyze samplings for herbicide residues. Irrigate crops with water containing herbicides, observe symptoms, determine yields, and analyze sampling for residues. Determine longevity of certain weed seeds in water and bottom soil. Study life history and physiology of selected weeds. Determine relations between carbohydrate reserves and effectiveness of control methods. Survey canals and impounded bodies of water to determine existing populations of aquatic and bank plants in various ecological situations. Repeat surveys to determine plant successions.

PROGRESS: Seventeen weekly xylene treatments initiated 2 weeks after emergence from tubers killed all sago pondweed. Under clipping or xylene treatments, usually the basal sago pondweed tuber of subterranean chains sprouted first and the end tuber remained dormant. No seed of foxtail barley, salt cedar, arroyo willow, wheat, or rye germinated after 3 mo in water, but some cattail seed germinated after 5 yr. Three sprinkler applications of fenac at .016, .03, or .16 ppmw in 2 in of water injured potatoes, beans, and soybeans. Only .16 ppmw reduced yields. Sugarbeets, corn, and sorghum were not injured. Carbohydrates in reed canarygrass roots and rhizomes were lowest (26% of total solids) at flowering and highest (36.5%) in January. Ten applications of paraquat at 1 lb/A, or 3 of dalapon at 20 lb/A or amitrole-T at 4 lb/A reduced the carbohydrates 50, 46, and 27%, respectively. Only 0.7% of canarygrass seeds stored dry at 72 F germinated after 1 yr, but 96 to 99% germinated when stored at 72 F in damp sand or at 34 F in damp sand or air. Density of shoots produced in 1 season from single rhizome buds of 6 canarygrass selections ranged from 847 to 2564 per sq. meter.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

2.0179, WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON

A.G. OGG, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP00036)

OBJECTIVE: Develop effective measures for controlling annual and perennial weeds in irrigated horticultural crops in Washington. Determine soil residues of persistent herbicides and relate to succeeding crop production. Evaluate the effect of certain weeds on the growth, development, and production of irrigated horticultural crops.

APPROACH: New or promising herbicides, alone or in combination with various cultural methods will be examined for annual and perennial weed control on research units and in cooperators, fields. Generally, percent weed control, crop tolerance, and yield will be used to evaluate the various weed control measures. Whenever possible, weed control measures will be evaluated under both furrow and sprinkler irrigation practices. Residues of soil persistent herbicides will be determined by analytical or biological methods and any residues found will be related to the production of succeeding crops. Soil fumigation will be thoroughly investigated as a method of controlling perennial weeds in irrigated cropland. Such factors as type of fumigant, rate, timing and depth of injection will be examined. Physiological and ecological studies will be conducted with certain troublesome weeds found in irrigated horticultural crops. Results will be used to develop improved weed control measures.

SUPPORTED BY Washington State Government - Olympia

2.0180, NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS

E.B. WELCH, Univ. of Washington, School of Engineering, *Seattle, Washington* 98105

A study of the relationship between pertinent environmental factors and the growth of nuisance algae in a highly eutrophic lake is proposed. The relative importance of light intensity, temperature, nitrate nitrogen and phosphate-phosphorus contents, degree of thermal stratification and detention time of the water in determining growth and species succession of the algae will be studied by field observation and statistical treatment of the data. As a potential method of algal control, the effect of nutrient dilution, with low-nutrient water, the presence of lake sediment, and water detention time on growth and species selection will be studied by in situ experiments in plastic bags. The usefulness of monitoring algal productivity in a lake by continuous measurements of dissolved oxygen in the surface water will be evaluated against the light- and dark-bottle method.

This study has particular relevance because of the future potential to evaluate flushing as a method of eutrophication control in Moses Lake.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0181, IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II

H.D. BRUHN, Univ. of Wisconsin, School of Agriculture, *Madison, Wisconsin*

The initial phase of this research project has investigated methods for the efficient mechanical processing and disposal of cut aquatic vegetation. Phase II of the program proposes to apply the results from the initial phase to the design, construction, and test operation of a pilot system for harvesting, processing, and disposal. The ultimate objective is the same as that in the original proposal -- 'to present feasible alternatives to time consuming and expensive handling and disposal methods, now commonly used, which are at the same time compatible with effective overall water management'.

It is planned to investigate in greater detail experimental processing and disposal procedures which have shown promise in tests to date. As substantial quantities of processed materials become available, utilization studies will be initiated, e.g., use of the press residue as an animal feed or a soil conditioner.

A second major effort will be the development of design criteria for higher speed cutting and collection systems. For efficient coverage in large, open lake areas, both rapid cutting and collection and rapid processing and disposal are required.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0182, IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION

H.D. BRUHN, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01576)

OBJECTIVE: Mechanize the harvesting and transportation of aquatic vegetation to reduce to a minimum the costs of labor, equipment, and the disposal of the residue.

APPROACH: Study dewatering procedures involving chopping, grinding, crushing and centrifuging to reduce the moisture content to a level at which dry matter combustion will be essentially self- sustaining. Study methods of liquifying aquatic vegetation making fluid type flow possible with subsequent treatment comparable to sewage disposal processes.

SUPPORTED BY Wisconsin State Government - Madison

2.0183, CHANGES IN WATER ENVIRONMENT RESULTING FROM AQUATIC PLANT CONTROL

G. COTTAM, Univ. of Wisconsin, Graduate School, *Madison, Wisconsin*

The effect of harvesting aquatic macrophytes was studied over a three year period by means of two plots, each 30 m by 30 m located in University Bay on Lake Mendota, Wisconsin. The plots were subdivided into nine compartments and were treated as follows: 1) Harvested 3 times, in June, July, and August. 2) Harvested twice, a) in June and July, b) in July and August. 3) Harvested once, a) in June, b) in July, c) in August. These plots, and their controls, were sampled four times, in June, July, August, and September. Sampling was done with SCUBA apparatus. The plants were cut six inches (15 cm.) above the bottom surface and were weighed and measured. The results indicate that one harvesting will reduce the amount of regrowth to about 50 per cent of that of the controls, two harvests will result in about 75 per cent reduction, and three harvests almost totally eliminated the plants for that year. Recommendations for harvesting heavily used areas are two harvests, one in mid June, and the other in July. August harvesting is not necessary in this climate, since the plants tend to break up regardless of treatment. None of the treatments had an appreciable effect on the subsequent years growth, even after two years of harvesting three times.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0184, LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS

J.C. ENSIGN, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01696)

OBJECTIVE: An inevitable consequence of pollution of water is the growth of blue-green algae. Large growth (blooms) come and go at periodic intervals. This project involves determining the role of blue- green algae degrading bacteria in the bloom disappearance. The enzymes involved will be isolated and studied. The feasibility of using them as algal control agents will be determined.

APPROACH: The numbers of blue-green algae and bacteria capable of lysing them will be determined in Lake Mendota, Wisconsin. Plates containing Anacystis and Anabaena will be inoculated with lake water and the plaques (lytic zones) counted. Bacteria capable of degrading blue- green algae have been isolated in this laboratory. The enzymes will be isolated and purified by conventional techinques. The mechanism by which they lyse algal cell walls will be determined. The enzymes will be tested in the laboratory and in the field to see if it is practical to use them to control the growth of algae. The effects on fish and other aquatic life will be determined.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0185, CHEMICAL CONTROL OF AQUATIC WEED NUISANCES

D.R. KEENEY, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01600)

OBJECTIVE: Evaluate aquatic herbicides in laboratory, growth chamber and natural environments with respect to herbicide specificity and degradability and the toxicity of the parent compounds and their degradation products in aquatic systems, increasing herbicide effectiveness by developing slow-release formulations, and effect of weed control on nutrient changes in lakes.

APPROACH: Available organic herbicides will be evaluated for their specificity and activity against common Wisconsin aquatic weeds, and the toxicity of their degradation products determined. Attempts will be made to develop controlled release formulations of promising aquatic herbicides. Artificial impoundments will be established in growth chambers and the biotron, and effects of weed kill on the nutrient status of the water and sediment will be elucidated. The principles developed in the above investigations will be tested in weed infested Wisconsin Lakes in cooperation with the Wisconsin Department of Natural Resources.

PROGRESS: Release of N and P from entothall-treated watermilfoil (Myriophyllum spicatum L.) was investigated using model sediment-water systems in the laboratory. The effect of sediment, sediment type, and aeration were included in the investigation. Without aeration, plant decomposition decreased the dissolved oxygen content markedly. The decomposing plants lost up to 80% of their weight in 10 weeks. The nitrogen percentage in the plant residue more than doubled while percent P decreased by about 20% in 6 weeks. Up to 70% of the P in the weeds was released by 6 weeks while about 50% of the N had been lost. More rapid release of N and P occurred in the presence of sediment than in lake water alone, and under aerated than non-aerated conditions.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

2.0186, METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S.

F.L. TIMMONS, Univ. of Wyoming, U.S.D.A. Crops Research Div., *Laramie, Wyoming* 82070

Research is conducted under laboratory, greenhouse, and field conditions to develop chemical and biological methods for the control of alligatorweed and other aquatic weeds such as water hyacinth, water lettuce, naiad, and others which clog navigation channels, irrigation and drainage ditches, and other waters in the Southeastern States and which interfere with boating, fishing, hunting, and other recreational activities. The research is conducted by the U. S. Department of Agriculture in cooperation with the Departments of the Army; Interior; and Health, Education and Welfare; the Florida U. S. Department of Agriculture in cooperation with the Department's Agricultural Experiment Station; Central and Southern Florida Flood Control District; Florida Fish and Game Commission, and other interested agencies including chemical companies. New and promising herbicides are evaluated for their effectiveness in controlling difficult-to-kill aquatic weeds in relation to environmental influences and including studies on factors affecting the absorption, translocation, and effectiveness of the chemicals and their disappearance pattern in water. The above studies and research on the Marisa snail and other biological control agents for aquatic weeds are conducted in Florida and adjoining states.

Work is also conducted in South America to find insects with sufficient specificity in their feeding habits to suppress alligatorweed and water hyacinth without causing any damage to beneficial ornamental plants, crop plants, or other valuable plants.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0187, CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA

F.L. TIMMONS, Univ. of Wyoming, U.S.D.A. Crops Research Div., *Laramie, Wyoming* 82070 (0710-02-09)

OBJECTIVE: Determine effectiveness and feasibility of soil-applied materials for control of aquatic plants. Develop practical and economic methods of controlling aquatic and ditchbank weeds and phreatophytes. Determine persistence and residual properties of the more effective herbicides in water and hydrosoil.

APPROACH: Make surface and incorporated application of herbicidal materials to the soil of irrigation ditches and lakes. Select promising herbicides and vary rate, method, and time of application in studies on control of specific weed pests. Use observation and bioassay techniques in recording residual properties of the materials. Study the ecology and life histories of important weeds as related to their control. Follow herbicide treatments with seeding of desirable plants and selective weed control by chemical and mechanical methods to develop long-range weed control by plant competition.

PROGRESS: Observations in 1969 showed that after annual treatments for 4 years, combinations with dalapon gave less satisfactory control of cattail than did those with amitrole and 2,4-D. Amitrole and 2,4-D, each followed by 2,4-D, gave 99% control. Dalapon followed by amitrole- T gave 91% control; dalapon followed by dalapon gave 40% control; and amitrole-T followed by either compound gave 75% control. Initial treatments in 1965 were dalapon 20 lb/A, amitrole 12 lb/A, 2,4-D 12 lb/A. In 1966, 1967, and 1969 additional treatments of dalapon at 10 lb/A, amitrole 6 lb/A, and 2,4-D 8 lb/A were made on subplots. Two years after rototilling there was 90% control of Carex in a light soil and less than 10% control in a heavier soil. Each of seven herbicides applied before rototilling increased the control to 80% or better in the heavier soil while four materials increased the control to 100% in the light soil. Without tillage, bromacil gave 90% control while other herbicides gave 60% or less control. Two years after annual post-emergence treatments with isocil, bromacil, and terbacil at 8 lb/A, there was 100% control of Carex. Five herbicides gave only 50% control of Carex. Three years after granular, soil-surface application of picloram at 2 1/2, 5, and 10 lb/A, the control of saltcedar was 92, 97, and 100%, respectively. Fenuron at 8 and 16 lb/A gave 90 and 100% control. Fenac at 10 and 20 lb/A gave 50 and 80% control.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - C.R.

2.0188, NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA

M. LEKIC, Inst. for Plant Protection, *Belgrade, Yugoslavia* (480E30ENT10)

OBJECTIVE: Find and evaluate insect and other natural enemies of the aquatic plant Myriophyllum spicatum in Yugoslavia and determine their suitability for introduction into the United States.

APPROACH: An ecological study will be made of habitats in Yugoslavia where Eurasian watermilfoil and other species of Myriophyllum occur. Insects or other organisms attacking the plant in ways that influence its abundance and dispersal will be determined. Life cycles of promising enemy species will be studied and tests will be conducted to determine their degree of host specificity. Species found to be useful and safe for introduction to United States will be sent to the USDA upon request.

PROGRESS: Ecological and life history studies of Myriophyllum continued. The weed was found in many new areas. In Yugoslavia, it is a problem usually only in canal and pond situations; it has been found in newly-built hydroelectric impoundments, but has not yet become a serious problem. A total of 15 species of insects have now been found feeding to some extent on milfoil -- 6 pyralid moths, 6 weevils, 2 aphids, and a chironomid. Of these, only the caterpillar Parapoynx stratiotata and the weevil Litodactylus leucogaster are found in sufficient numbers on the weed and are sufficiently specific to be promising control agents. The weevil causes less damage to the weed than does the moth; it has been found only on Myriophyllum spp. in Yugoslavia. Biological and ecological studies on the weevil were made, and preliminary specificity tests begun; no larval feeding occurred on the 5 test plants. A detailed biological study of Parapoynx was made. This caterpillar has been found only on Myriophyllum spicatum, M. verticilatum, and Ceratophyllum demersum in Yugoslavia. It has been reared in the laboratory from individual plants of these and 7 other plant species. But when reared in the presence of all 10 test plants, Parapoynx fed only on M. spicatum (90%) and M. verticilatum (10%). Laboratory infection of Myriophyllum with 4 species of Fusarium was successful and the fungi conidia remained virulent under laboratory conditions. These 4, and 3 other species belonging to other genera were the most important fungi found on milfoil.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

2C. FISH

(Control of Lamprey or Rough Fish or the Chemical Manipulation of Fish Populations for Sampling Harvesting or Transferring Purposes)

2.0189, EXPERIMENTAL USE OF PESTICIDES FOR FISHERIES MANAGEMENT PURPOSES

J. LINN, State Dept. of Fish & Game, *Sacramento, California* 95819

Study Objectives: Assist in the development of methods to enhance beneficial fish and wildlife populations through the use of pesticide for selective habitat development and control of undesirable fish and wildlife populations.

Job Objectives: To locate and test suitable candidate toxicants for use in removing or reducing unwanted fish populations.

Procedures: Search the literature and contact research groups now developing and testing new pesticides for possible candidate materials. Obtain adequate data, either from other agencies or by testing at the Field Stations or in the field, to determine toxicity to fish of selected candidate materials. Provide technical assistance to regional personnel in the field testing of selected materials.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0190, SMALL IMPOUNDMENT STOCKING

D.T. WEBER, State Div. of Game Fish & Pks., *Fort Collins, Colorado* 80521

Procedures: 1. To collect basic survey data from 8 of the Banner Lakes. 2. To eradicate the fish population from 5 of the lakes surveyed under Procedure 1. 3. To stock bass only in 2 of the 5 lakes eradicated under Procedure 2 and bass-bullheads in the remaining 3 lakes. 4. To maintain stocking of conglomerate species in the remaining 3 lakes to serve as controls. 5. To measure harvest from the lakes under study after each is stocked.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0191, STUDIES OF SHARK REPELLENTS AND OTHER ANTISHARK MEASURES

H.D. BALDRIDGE, U.S. Navy, Aerospace Medical Inst., *Pensacola, Florida* 32512

The predatory habits of sharks represent both a physical, as well as psychological hazard to naval personnel engaged in swimmer/diver operations, recreation or survival. Behavioral responses by sharks to physico-chemical factors introduced into their environment are being evaluated, in terms of possible effectiveness as shark deterrents, by the principal investigator. A central clearing house, with an automatic data processing method for assimilating shark attack reports received from all over the world will provide important background details beneficial to shark studies.

Laboratory and field tests of chemical and physical shark deterrents are being conducted at Mote Marine Laboratory in Florida and the Lerner Marine Laboratory in the Bahamas. The behavioral responses of sharks to known concentrations of drugs and shark repellents are being evaluated. Of particular interest will be any relationship of chemical repellents to feeding inhibition of relatively excited hungry adult sharks in the presence of an attractive food source. Data processing of the international shark attack file will continue.

Procedures for assimilating and codifying information in the international shark attack file have been expanded and refined to permit analysis of some 1,500 files, ranging in content from newspaper clippings to detailed scientific reports. Data collected in earlier studies on the responses elicited from young lemon sharks by waterborne drugs (MS-222, quinaldine, strychnine and sodium cyanide) were reduced mathematically in a manner serving to demonstrate the applicability of classical rate theory to the study of shark deterrents.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0192, HAUL SEINE STUDY

F.J. WARE, State Div. of Game & Fish, *Tallahassee, Florida* 32301

Objective: To improve sport fishing by population manipulation through mechanical means.

Procedures: Intensive harvest of all fishes, excluding largemouth bass and striped bass, will be attempted in Lake Hollingsworth (365 surface acres) by haul seining. Removal of 100-150 pounds of fish per surface acre annually is proposed, or until a desirable population structure is achieved. Background population studies indicate the fishery is dominated by gizzard and threadfin shad, brown bullhead, and stunted panfish species, comprising approximately 90% of the total. It is believed the proposed harvest would remove between 60-75% of the lake's fish population. Haul sein specifications are as follows: length 600 yards, depth 9 feet, wing mesh 3 inch stretch, bunt mesh 2 1/2 inch stretch, and pocket mesh 2 inch stretch. Determinations will include the effects of haul seining on sport fishing and the qualitative improvement of the fish population. Results will be evaluated by two principal methods: (1) a non-uniform probability creel operated in cooperation with North Carolina State University, and (2) four 1-acre block net-rotenone samples conducted bi-annually. Both evaluation methods have been initiated prior to the seining program to establish background criteria. These data will provide before and after estimates for fishing pressure, catch, success, population structure and standing crops.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0193, STRIPED BASS STUDIES

F.J. WARE, State Div. of Game & Fish, *Tallahassee, Florida* 32301

Objective: To evaluate the striped bass, Roccus saxatilis, as a biological control of over-populated forage fish, principally gizzard and threadfin shad, Dorosoma cepedianum and D. pentenense. Secondly, to measure the contribution of striped bass to the sport fishery.

Procedures: The successful establishment of striped bass in Lake Hollingsworth justifies additional research in other lakes. Two study areas will be used. Lakes Hunter and Parker with surface acreages of 100 and 2,272 respectively. Recent studies indicate both lakes support shad populations in excess of 50% by weight of the total fish. Stocking rates of fingerling striped bass will be as follows: Lake Hunter 30 per acre 83,000); Lake Parker 10 per acre (22,720). Repetative annual stockings are to be made at the rate of 10 fingerlings per acre to maintain successive year-classes. Biological control of shad species will be tested in each lake. Principal method of evaluation will be the 1-acre block net-rotenone technique although gill nets, seines, etc., will be frequently used to determine the status and general condition of the striped bass. Block net sampling will be performed prior to stocking in order to establish species composition and standing crops. Thereafter, block net sampling (4 samples) will be conducted bi-annually to monitor effects of striped bass on shad populations. In Lake Hunter a non-uniform probability creel, statistically designed by North Carolina State University, will be employed to measure the shad control effects, if any, on sport fishing and what contribution the striped bass itself makes in the creel.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0194, RESTORING 'BALANCE' WITH ROTENONE AND FINTROL

W.W. THOMASTON, State Game & Fish Commission, *Atlanta, Georgia* 30334

Study Objective: To evaluate methods of restoring 'balanced' conditions in small impoundments to provide a satisfactory fish harvest.

Job Objective: To evaluate the effectiveness of rotenone and Fintrol for correcting imbalance in small impoundments.

Procedures: Partial or selective poisoning using rotenone and Fintrol will be carried out to reduce the intermediate bluegill population or to remove undesirable species of fish. Various techniques will be used and/or developed by project personnel in conjunction with pond owners: Approximately 10 ponds will be used.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0195, SQUAWFISH CONTROL IN CASCADE RESERVOIR

R. IRIZARRY, State Fish & Game Department, *Boise, Idaho*

Study Objectives: To ascertain if the large scale partial eradication of squawfish spawners and fry results in decreased squawfish catches and improved game fish growth and harvest. To monitor the Cascade Reservoir Fisheries and provide data for management purposes.

Job Objectives: The primary objective is to determine if the squawfish population can be significantly reduced by annual eradication of adults. The eradication program will be evaluated by making before- and-after comparisons of game fish and squawfish catches by anglers and in nets and by noting changes in fish growth and survival rates.

Procedures: Squoxin, a newly developed, selective chemical, kills squawfish without harming trout at concentrations of 0.1 ppm. A test of Squoxin in 1968 showed that the 18-mile long North Fork of the Payette River, the major Cascade Reservoir spawning tributary, could be successfully treated for squawfish control. In 1970, the project biologist will monitor the movement of squawfish into the three principal tributaries by sampling key holes along each tributary with explosives. When it appears that the spawning runs are in the tributaries, Squoxin will be dispensed from drip stations. Stations will be moved progressively downstream, leap-frog fashion, as the squawfish die upstream (management activity). Sample stream sections will be surveyed to estimate squawfish numbers killed and the age and sex composition of the run. Post-treatment sampling will establish if additional spawners move into the streams. Second treatments may be needed but are not likely if the results of past treatments are duplicated. Selected pools in the tributaries will be sampled with explosives bi-monthly throughout the summer to establish if squawfish move back into the streams. A creel census is conducted to measure the total catch of game fish and squawfish. The census clerk will estimate total daily fishing hours by making repeated counts of all anglers throughout the day and multiplying the average angler count by total daylight hours. Gill net sets will be made at established stations in mid-summer to obtain index of abundance data on all species and to determine the vertical stratification of game and nongame species. Growth rates and condition factors of game fish and squawfish will be measured by standard length-weight samples and scales obtained from the fish.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0196, SOUAWFISH STUDIES--ST. JOE RIVER, IDAHO

J.F. KEATING, State Fish & Game Department, *Boise, Idaho*

Study Objectives: To study selected life history phases, distribution, and abundance of cutthroat trout and northern squawfish in the St. Joe River and tributaries in order to provide basic information needed to develop an improved trout management program.

To measure and evaluate the physical and biotic habitat of the St. Joe River drainage as related to the production of fish, primarily cuttroat trout, to provide basic information needed to develop an improved trout management program.

To assess the desirability of a proposed Squoxin (selective squawfish toxicant) treatment of the St. River, to determine the need for, the extent and the timing of said treatment, and to establish before-and-after studies to evaluate the treatment:

Job Objectives: To evaluate a Squoxin (selective squawfish toxicant) treatment and to improve techniques and modify application rates downward.

Procedures: We will treat the lower 30 miles of the St. River with squoxin at a concentration of approximately 30 parts per billion in late June or early July, 1971. Last year the administered rate was 100 parts per billion.

Squoin is forced from their original drums by air pressure (5 p.s.i.) controlled by valves. A 3-man crew will treat the river in a 35-hour period.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0197, SURVIVAL AND GROWTH OF KOKANEE AND COHO SALMON IN ANDERSON RANCH RESERVIOR

H. POLLARD, State Fish & Game Department, *Boise, Idaho*

Study Objectives: To evaluate the effects of annual partial control project in which newly hatched squawfish fry along the shoreline are treated with rotenone each summer. To evaluate kokanee salmon introductions and natural reproduction and relative benefits of the hatchery trout plantings.

Job Objectives: To monitor the growth and survival of kokanee salmon stocked in Anderson Ranch Reservoir, to assess the survival of natural reproduction of kokanee in tributaries of Anderson Ranch Reservoir.

Procedures: Kokanee fingerlings stocked are fin clipped so that hatchery and natural stocks can be separated in the creel and the spawning ground surveys. Survival of planted kokanee to maturity will be measured by estimates of spawners counted in tributary spawning areas. Spawning runs of 6,000, 15,000 and 30,000 were noted in 1967, 1968, 1969 and 1970. Estimates of the total angler catch of both kokanee and coho will be made from creel census data collected in Job III-a. Length-scale samples will be used to verifty age-class structure.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0198, ROTENOIDS FROM TEPHROSIA VOGELII

W.H. TALLENT, U.S. Dept. of Agriculture, Northern Utilization Res. Div., *Peoria, Illinois* 61604 (N5-5-54)

OBJECTIVE: Study the extraction, composition, analysis, and utilization of rotenoids from Tephrosia vogelii for use in insecticidal and fish-killing formulations and develop specific analytical methods for identifying individual rotenoids.

APPROACH: Develop analytical procedures for distinguishing between rotenone and deguelin, and test reliability of procedures on synthetic mixtures of rotenoids. Study the extraction, both for analysis and production, of rotenoids from T. vogelii, considering relative merits of extraction methods selective for rotenoids versus less selective ones, followed by reasonable refinement steps. Isolate and characterize individual components suspected of having significant influence on utility of rotenoid-containing extracts.

PROGRESS: Rotenoids can be extracted efficiently from dry powders of Tephrosia vogelii leaves. Chloroform, methylene chloride, and acetone were the most effective of 11 solvents for extraction by steeping at room temperature. Hexane was least effective, yet aqueous hexane gave the purest extracts. With fresh leaflets, which yield up to 20% more total rotenoids than dried material, hexane is as effective as acetone in Soxhlet extractions. Freezing leaflets reduces rotenone yield but does not significantly alter the amount of extractable deguelin. Rotenone and deguelin can be separated from tephrosin and several other contaminating materials present in crude extracts by preparative-scale chromatography on silica gel. Deguelin of 70 to 90% purity (ultraviolet analysis) has been isolated from a rotenone- deficient variety of T. vogelii. Plants of 23 varieties representing 17 species have been grown, collected, and separated into their component parts for study of their content of individual rotenoids. Investigation of procedures for faster and more convenient rotenoid analysis also continues.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - U.R.N

2.0199, BIOLOGICAL AND LIMNOLOGICAL INVENTORY OF SEVEN FLOOD CONTROL RESERVOIRS IN THE STATE OF INDIANA

D.J. MCGINTY, State Div. of Fish & Wildlife, *Indianapolis, Indiana* 46204

The objectives of this study are to: (1) Evaluate fish eradications projects in the watersheds of large flood control reservoirs prior to the impoundment of water; (2) Evaluate different fish stocking methods used to determine their long range effects upon reservoirs; (3) Determine future reservoir needs for corrective fish management measures for fish stocking, methods of taking, water level manipulation, and fish population controls; (4) Estimate fishermen usage and harvest rate so that the sport fishery value may be determined for economic purposes and to determine methods of increasing the angler success rate; (5) Establish baseline data whereby the reservoirs program within Indiana can be compared with research and management programs developed by the other agencies, by the Bureau of Commercial Fisheries, the Bureau of Sport Fisheries and Wildlife, at Fayetteville, Arkansas and Yankton, South Dakota.

The fishery population will be inventoried by using experimental gill nets, boat mounted electro-fishing gear, rotenone embayments, and creel census. Monroe, Salamonie, and Mississinewa Reservoirs will be sampled yearly by use of all sampling methods. Cataract, Raccoon, Eagle Creek, and Huntington Reservoirs will be sampled on alternate years by gill netting and electro-fishing. Eagle Creek and Raccoon Reservoirs will be sampled in 1970; Cataract and Raccoon Reservoirs will be sampled in 1971. All fish collected will be counted, weighed, measured, and scale samples taken for aging. The inventory will consist of a four week inventory on Monroe Reservoir, one week inventories on Huntington and Eagle Creek Reservoirs, and two week inventories on all other reservoirs. Rotenone embayment samples will consist of three embayments on Monroe Reservoir, and two embayments on Salamonie and Mississinewa Reservoirs. Embayment sampling will be carried out in the spring of the year. Water temperature and water chemical data will be taken at two week intervals.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0200, STUDY OF THE SEA LAMPREY IN LOVE LAKE

K.A. HAVEY, State Dept. of In. Fish & Game, *Augusta, Maine* 04330

Objectives: (A) To determine size and characteristics of adult lamprey runs, (B) To determine incidence of parasitism by juvenile lampreys on Love Lake fish.

Procedures: Migrations of adult and juvenile lampreys will be enumerated at the Northern Stream trap. The usual data will be tabulated. All adult lampreys entering Love Lake will be disposed of at the outlet trap. Records will be kept of incidence of lamprey attacks on Love Lake fish. Inasmuch as water conditions permit, juvenile lampreys leaving the lake in fall and spring will be disposed of at the trap.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0201, JO-MARY POND RECLAMATION

P.S. ANDREWS, State Dept. of In. Fish & Game, *Bangor, Maine*

Perspective: Studies of management techniques and their effects on a wild, self-sustaining brook trout population have been underway for the past nine years at Jo-Mary Pond. Data were collected on population dynamics, growth and structure of both brook trout and rough fish (primarily white suckers, lake chubs and creek chubs) during an extended period of closure to angling and during alternate year closure. A complete creel census was implemented during those periods when angling was allowed. The objectives of testing alternate year closure as a management technique have been met and the nature of the resultant fishery is adequately defined. Redirection of some project objective is now indicated.

Objectives: 1. Remove the effects of rough fish abundance on the trout population under study. 2. Measure quantitatively the effects of rough fish removal on a known brook trout population on which considerable growth, survival, age structure and production data have been compiled. 3. Continue to test various management policies and techniques which may have broad application in the future management of brook trout on a state-wide basis, and measure results on the brook trout population. 4. Collect specific and complete creel census data on a reclaimed pond and measure the effects of management changes on the fishery.

Procedure: A suitable barrier dam will be constructed at the pond outlet to prevent reestablishment of unwanted species. Prior to reclamation, mature brook trout will be captured and held for spawning to provide offspring of the same genetic stock for reintroduction to the pond. The Pond and tributaries will then be treated with five percent emulsifiable rotenone at 0.5 ppm concentration. After detoxification, the pond will be restocked the following spring with advanced fry at a rate to be determined when brood production can be evaluated. A number of fry will be held in the hatchery to be stocked as fall fingerlings on the following fall. The latter will be marked and will thus provide an opportunity to determine comparative survival of unmarked spring fry.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0202, ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70

M. KELLER, State Fish Division, *Lansing, Michigan* 48926

The native lake trout stocks in Lake Michigan became extinct by the mid fifties from sea lamprey predation and over-exploitation by commercial fishermen. In Lake Michigan, programs to control sea lamprey and re-establish lake trout are being carried out under the auspices of the Great Lakes Fishery Commission with state and federal agencies participating. Chemical treatment of sea lamprey was initiated in 1960, and present control is believed to be at a level that will allow restocking of the lake with salmonid species. The lake trout restoration program began in 1965, and to date over nine million yearling, finclipped fish have been stocked. Stocking will continue until a self-reproducing population is established. Studies on evaluating lake trout restoration have been underway since 1965. Annual and semi-annual progress reports have been presented at the annual and interim meetings of the Great Lakes Fishery Commission on the status of stocks. The project assessment of lake trout restoration in Michigan waters of Lake Michigan is an expansion of past studies.

Objectives: The primary objective in assessment of lake trout stocks is to describe their condition in Michigan waters of Lake Michigan. An accurate appraisal of the stock will depend upon information secured from several sources: (1) Progress and effectiveness of sea lamprey control by geographical areas of the lake (2) Survival of planted trout as affected by exploitation by the commercial and sport fisheries, and predation (3) Dispersal and distribution of yearly groups of planted trout (4) Utilization of food supplies, growth, maturation and spawning success by geographical areas (5) Associations with other species (6) Effects of chlorinated hydrocarbons on the reproductive potential, survival and growth of the species (7) Effects of internal and external parasitism on the species (8) Economics from the sport and commercial fisheries statistics.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0203, SEA LAMPREY CONTROL - LAKE MICHIGAN CHEMICAL CONTROL

W.E. GAYLORD, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Lundington, Michigan* 49431

The Bureau of Commercial Fisheries, under the direction of the Great Lakes Fishery Commission, is using selective larvicides as an experimental method of control for sea lampreys in Lake Michigan. The study is designed to eliminate all generations present in the streams tributary to the lake by treatment of these streams with chemicals, and to determine if such action will control effectively the parasitism on lake trout and other fish.

The control method requires a thorough knowledge of: the presence and distribution of ammocete populations in tributaries; physical characteristics and flow data of infected streams, accurate bioassays and chemical analyses of the water; precise metering of the chemicals; and post-treatment surveys to measure and analyze the effectiveness of individual treatments.

A total of 99 Lake Michigan streams contain sea lampreys. All streams were treated by July 1966. Treatments since then have been repeated at approximately 4-year intervals or at intervals determined from observations on the rate of reestablishment and growth of sea lampreys.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0204, SEA LAMPREY CONTROL - LAKE HURON CHEMICAL CONTROL

G.A. ANDERSON, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Marquette, Michigan* 49855

The Bureau of Commercial Fisheries, under the direction of the Great Lakes Fishery Commission, is using selective larvicides as an experimental method of control for sea lampreys in Lake Huron. The study is designed to eliminate all generations present in the streams tributary to the lake by treatment of these streams with chemical, and to determine if such action will control effectively the parasitism on lake trout and other fish.

The control method requires a thorough knowledge of: the presence and distribution of ammocete populations in tributaries; physical characteristics and flow data of infected streams, accurate bioassays and chemical analyses of the water; precise metering of the chemicals; and posttreatment surveys to measure and analyze the effectiveness of individual treatments.

There are 51 tributaries along the U.S. shore of Lake Huron known to contain sea lampreys. Three of these were treated in 1962. Treatments in this area were resumed in 1966 and 36 streams were treated.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0205, LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY

R.A. BRAEM, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Marquette, Michigan* 49855

The Bureau of Commercial Fisheries, under the direction of the Great Lakes Fishery Commission, is using selective larvicides as an experimental method of control for sea lampreys in Lake Superior. The study is designed to eliminate all generations present in the streams tributary to the lake by treatment of these streams with chemicals, and to determine if such action will control effectively the parasitism on lake trout and other fish.

The control method requires a thorough knowledge of: the presence and distribution of ammocete populations in tributaries; physical characteristics and flow data of infected streams, accurate bioassays and chemical analyses of the water; precise metering of the chemicals; and post-treatment surveys to measure and analyze the effectiveness of individual treatments.

There are 75 streams tributary to the U.S. shore of Lake Superior containing sea lampreys. The initial treatment of these streams was completed in 1961. The second application was finished in 1964. Since then treatments have been repeated at intervals determined from observations on the rate of reestablishment and growth of sea lamprey ammocetes.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0206, SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES

P.J. MANION, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Marquette, Michigan* 49855

The Bureau of Commercial Fisheries and the Fisheries Research Board of Canada, under contract with the Great Lakes Fishery Commission, are using specific larvicides in the experimental control of the parasitic sea lamprey in the Great Lakes. To pursue an efficient and economical program to control the sea lamprey it is essential that the larval phase of the life history be fully documented since selective larvicides have been developed which destroy the ammocete of the sea lampreys. This project is designed to obtain maximum data on the growth, movement, metamorphosis, and ecology of a known-age population of ammocetes established in the Big Garlic River, Marquette County, Michigan, to compare with natural situations.

An all-weather trap was constructed below the lower limits of the known-age population to intercept all ammocetes and recently metamorphosed sea lamprey moving downstream.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0207, SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES

H.A. PURVIS, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Marquette, Michigan* 49855

The Bureau of Commercial Fisheries and the Department of Fisheries of Canada, under contract with the Great Lakes Fishery Commission, are using specific larvicides in the experimental control of the parasitic sea lampreys in the Great Lakes. Ammocetes of the sea lamprey demonstrate a wide variation in growth in age at metamorphosis in streams tributary to the upper Great Lakes. Present information indicates initial metamorphosis and migration of a year class may occur in as little as 2 years or as long as 7 years. Large streams with fast rate of larval growth pose the greatest problem to the control problem. To effectively and economically control the sea lamprey the selective larvicide must be applied to each stream before the metamorphosed lampreys migrate to the Great Lakes.

Reestablishment studies will be concentrated on the larger streams with rapid rate of larval growth and a high potential for producing large numbers of parasitic-phase lampreys. Data to substantiate accurately the age at metamorphosis will depend on the recovery of recently metamorphosed sea lampreys from populations reestablished after chemical treatment of the stream. It will be necessary using electric shockers, chemicals, and fyke nets, or by use of biological indices such as sex ratios, growth rates, or length of the larvae to separate ammocetes reestablished after chemical treatment from lampreys that may have escaped the larvicide. Ammocetes will also be marked at a known age and their growth and time to metamorphosis monitored.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0208, SEA LAMPREY CONTROL - ASSESSMENT METHODS

P.C. RUGEN, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Marquette, Michigan* 49855

The Bureau of Commerical Fisheries and the Fisheries Research Board of Canada, under contract with the Great Lakes Fishery Commission, are using specific larvicides in the experimental control of the parasitic sea lamprey in the Great Lakes. Studies of assessment methods are designed to provide an inexpensive and efficient method of assessing sea lamprey abundance and evaluating the effects of chemical control.

Larval sea lamprey populations are being monitored in selected index streams tributary to the three upper Great Lakes. Permanent survey stations established in the streams will be examined systematically to assess changes in ammocete abundance, distribution, and age composition. The fluctuations in relative abundance may reflect the general effects of chemical control on the number of potential recruits to the adult population. As this study is based primarily on the monitoring of larval populations, it will be possible to accomplish most of the work in conjunction with normal stream survey assignments and incorporate pertinent data from other facets of the lamprey program. All information is being collected at the Marquette Station for evaluation, adaptation to ADP use, and inclusion in a catalog of information of all streams tributary to the United States side of the Great Lakes.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0209, LAKE HURON CHEMICAL CONTROL

B.R. SMITH, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Marquette, Michigan* 49855

The Bureau of Commercial Fisheries, under the direction of the Great Lakes Fishery Commission, is using selective larvicides as an experimental method of control for sea lampreys in Lake Huron. The study is designed to eliminate all generations present in the streams tributary to the lake by treatment of these streams with chemical, and to determine if such action will control effectively the parasitism on lake trout and other fish.

The control method requires a thorough knowledge of the presence and distribution of ammocete populations in tributaries; physical characteristics and flow data of infected streams, accurate bioassays and chemical analyses of the water; precise metering of the chemicals; and post-treatment surveys to measure and analyze the effectiveness of individual treatment.

There are 48 tributaries along the U. S. shore of Lake Huron known to contain sea lampreys. Three of these were treated in 1962. Treatments in this area were resumed in 1966 and 18 streams were treated.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0210, BIOLOGY OF THE LARVAL SEA LAMPREY

L.H. HANSON, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Millersburg, Michigan* 49759

A complete knowledge of the biology of larval lampreys is necessary to take full advantage of control techniques which are directed toward this life history stage of the sea lamprey. Evaluation of control methods requires a thorough knowledge of the factors which control the size, growth and transformation of larval populations. Studies are being conducted or planned to determine the effect of environmental factors such as temperature and water chemistry on developing sea lamprey embryos. Also being investigated is the effect of biologically active chemicals on the sequence and success of embryological development. Taxonomic studies are under way on young-of-the-year ammocetes of the five species found in the Great Lakes. These studies utilize individuals of known parentage. The effects of environmental factors such as temperature and food on ammocete growth and transformation are being studied. This information is vital to an understanding of ammocete distribution and their reaction to an abnormal or hostile environment.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0211, BIOASSAY

J.H. HOWELL, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Millersburg, Michigan* 49759

Research is directed toward the discovery of chemicals which, when in a stream environment, will be selectively toxic to larval sea lamprey (Petromyzon marinus). The procedure consists of bioassaying a wide variety of organic compounds, representing most of the basic structural classes, under standard conditions against larval sea lamprey and rainbow trout (Salmo gairdnerii). The discovery of a chemical possessing the desired biological activity (toxicity and selectivity for larval lamprey) results in the testing of structurally related compounds. The relation between molecular structure and biological activity are studied and compounds custom synthesized to produce the best possible biological activity. Chemicals selected for field use are tested to determine what effect environmental factors such as water chemistry, temperature, turbidity and light have on their biological activity. Tests are run on promising compounds to determine their toxicity to a variety of game and nongame fish species as well as aquatic invertebrates. Methods are devised for preparing concentrated stock solutions of compounds being considered for field use. Analysis techniques, which are fast and accurate are developed. A chemical's potential as a sea lamprey control agent is evaluated under simulated stream conditions and in carefully controlled experimental stream treatments.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0212, LAKE SUPERIOR COMMERCIAL FISHERIES ASSESSMENT STUDIES

C. BURROWS, State Div. of Game & Fish, *Saint Paul, Minnesota* 55101

Objectives: The primary objective is to ascertain the condition of the lake trout and other commercial fish stocks in Minnesota waters of Lake Superior. To meet this broad objective, it will be necessary to determine the: 1. Progress and effectiveness of sea lamprey control in the local area. 2. Survival and dispersal of stocked trout. 3. Relative abundance and size and age distribution of the trout and other commercial fish populations. 4. Commercial fish production. 5. Degree of interaction or interference between types of fishing in these waters.

Procedures: The following procedures are set forth in general terms to allow for amendments which may be necessary to accomodate the recommendations of the Lake Superior Committee of the Great Lakes Fishery Commission.

With support from this project, a Department man will be on board the vessel lifting the lake trout assessment, test nets to verify catches and record detailed information on the individual trout. Data on length, fin clips, and lamprey marks will be recorded and scale samples will be taken for aging. Similar data will be gathered on other salmonids in the catch.

Herring and chub net lifts will be spot checked to assess damage to small lake trout and determine the incidence of other salmonids in the catch.

Commercial fishing production reports will be collected and analyzed to obtain the statistics necessary for management.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0213, EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP, SOFT-WATER LAKES

R. HASSINGER, State Div. of Game & Fish, *Saint Paul, Minnesota* 55101

Objective: To determine whether fintrol is a practical agent for the rehabilitation of large, lake trout waters.

The toxicant will be used at 1/5 of the normal concentration used in southern Minnesota lakes. Its effect of rough fish removal will be evaluated.

2. AQUATIC PEST CONTROL

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0214, EXPERIMENTAL ESTABLISHMENT OF MONOSPECIFIC WALLEYE POPULATIONS AS A MANAGEMENT MEASURE FOR SMALL WARMWATER LAKES IN NORTHERN MINNESOTA

F.H. JOHNSON, State Div. of Game & Fish, *Saint Paul, Minnesota* 55101

The objective is to evaluate the angling potential of single species walleye populations and walleye in combination with minnows in small reclaimed warmwater lakes in northern Minnesota and determine optimum stocking rates and frequency.

Management of small rehabilitated lakes for stream trout involves the removal of competing species with a fish toxicant and channelling the productivity thus released into greater trout yields. This has become a well established trout management technique for suitable small lakes in Minnesota and elsewhere. The ecology of the walleye suggests that this species may have some potential for similar management in small warmwater lakes that are landlocked and not now producing sustained good fishing. Walleye fry have often been stocked in marginal fish lakes following winter kills and here they have survived well and often provided good angling. In northern Minnesota there is a substantial acreage of small lakes that are too shallow and warm for trout and in which diversified populations of warm-water fish now produce poor angling. As the demand for greater yields from the natural walleye waters of the state continues, a method of adding new acres of walleye water to the resource base would be of considerable value.

There are two small lakes, one hardwater and one softwater, which previously collected data indicate are suitable for reclamation. The softwater lake contains forage organisms of a kind and abundance which previous experience indicates will likely support both fingerling and adult walleye without benefit of additional forage. The hardwater lake contains organisms of a kind which will provide forage for walleye fingerlings but which require conversion by minnows to provide forage of a suitable size for adults.

Procedure: Job 1. Obtain estimates of the total standing crop of fish on the two selected study lakes prior to treatment with fish toxin for a rough indication of their carrying capacity for walleyes in monospecific association. Job 2. Remove with fish toxin all of the fish from the two selected study lakes prior to stocking with walleye fingerlings. Job 3. Establish walleye populations with fingerling stocking in the two study lakes. Job 4. Determine the carrying capacity of the two lakes with population estimates in spring and fall.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0215, THE INTERACTION OF THE WALLEYE AND WHITE SUCKER IN THE FISH POPULATION OF SOFT WATER LAKE IN NORTHEASTERN MINNESOTA

F.H. JOHNSON, State Div. of Game & Fish, *Saint Paul, Minnesota* 55101

A. Objective: To determine the response of the fish populations, with particular emphasis on the walleye Wilson Lake following sucker removal. B. Justification: See Study II, Investigations in Progress - Walleye Studies. Data obtained to date indicate the walleye and perch population are still responding to the intensive reduction in the sucker population. Information is needed on whether the walleye pop. will stabilize at higher level as a result of sucker removal, the effect on the fishing harvest, and the reaction of the sucker pop. for a period of years following removal. C. Procedure: 1. Assess development of the dish populations. 2. Measure sport fishing pressure and harvest.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0216, EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP SOFTWATER LAKES

R. MICKLUS, State Div. of Game & Fish, *Saint Paul, Minnesota* 55101

The objective is to determine whether fintrol is a practical agent for the rehabilitation of large, lake trout waters.

Lake trout populations in many of the accessible Northeastern Minnesota lakes have declined or disappeared following the introduction of walleyes in the 1930's. While the walleye has proven to be a game fish better able to provide summer fishing on the more intensively developed lakes, it is desirable that lake trout populations be reestablished in some of the lakes of this region.

In the light of past experience with trout stocking, the best survival can be anticipated in stocking after rehabilitation. What is needed is a fish toxin which is effective on all of the species in the region, which can be uniformly applied over large, deep basins, and which is not prohibitively expensive.

Antimycin, or fintrol of Ayrst Laboratories, promises to be such a toxin. In the soft waters of this region, it can be used at 1/5 of the concentration necessary in the southern part of the state, and it affects only the fish. Invertebrate populations are unaffected with the result that food is usually abundant at time of stocking.

We need to know if this material can be effectively distributed in the deep strata of these waters. We also must know the detoxification time and the minimum effective concentrations.

Procedure: Job 1. Assess fish populations of the study lakes, Mayhew, Little Mayhew, Birch, and Moss Lakes in Cook County. Job 2. Bio-assay of waters and application of toxin. Job 3. Restocking of lake trout.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0217, THE USE OF PHEROMONES BY CARP, CYPRINUS CARPIO-RESEARCH

E.R. KENDLE, State Game & Parks Commission, *Lincoln, Nebraska* 68509

Objective: The purpose of this job is to determine if carp make use of pheromones in intraspecific communication and if a pheromone is important in sex discrimination, attraction and/or stimulation.

Past and continuing studies have indicated that some species of fish make use of pheromones in intraspecific communication. The use of these pheromones for management purposes particularly during the fish's breeding season could significantly add to our ability to control troublesome populations of fish. However, the use of pheromones by any given species must be documented.

Procedures: Existing laboratory equipment which is arranged to give each of six fish a choice between two water sources will be utilized to determine the ability of small carp (6' to 10' in total length) to differentiate through the sense of smell between other individuals. This will also provide the investigator with experience in working with this species prior to conducting tests with adult carp. Coinciding with the work on small carp will be the injection of a few adult carp with pituitaries to determine what, if any, problems may be expected in the use of this technique on the carp in the laboratory.

The laboratory will then be arranged to handle large carp. This will involve the arrangement of three six-foot horse tanks to provide the adult fish with a choice between two water sources. The source tanks will be two 99-gallon aquaria. During the tests water will be pumped from both source tanks to each experiment tank and the behavior of the experimental fish observed and recorded. The experimental fish will have been brought into a sexually active condition through the use of pituitary injections prior to testing. Tests will be made utilizing each sex as the experimental fish. One fish each will be placed in each of the two source aquaria. One will contain a male whereas the other will contain a female. The statistic to be used in the analysis of these data will be the chi square test as recommended by Dr. Robert Mumm of the University of Nebraska Statistical Laboratory.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0218, EXPERIMENTAL RESTORATION OF THE GILA TROUT

UNKNOWN, State Dept. of Game & Fish, *Santa Fe, New Mexico* 87501

P.P.S.OBJECTIVE: To select suitable waters to perpetuate the Gila trout.

P.P.S. Procedures: 1. Select suitable streams. 2. Construct barriers to prevent upstream migration of undesirable fish. 3. Rotenone stream to eliminate undesirable fish. 4. Transfer Gila trout to selected streams. 5. Check success or failure of introductions.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0219, RELATION OF LAMPREY EELS TO EXISTING SALMONID STOCKS IN CAYUGA LAKE

R.G. WERNER, State Conservation Department, *Albany, New York* 12226

Objectives: To enumerate the adult lamprey population using Cayuga Inlet for spawning and to prevent them from reaching the spawning grounds. To relate the abundance of lampreys to an index of their activity obtained from scar and wound counts on lake trout and rainbow trout. To obtain new statistics on total mortality rates of lake and rainbow trout after the lamprey population has been reduced.

Procedure: 1. Enumerate lamprey spawning run. a. Trap, count, sex, measure and then destroy lamprey population using fishway on Cayuga Inlet. b. Relate run intensity to environmental factors such as temperature and flow. c. Some effort may be expended in sampling outmigration of transformed lamprey. 2. Determine relation between lamprey scar and wound index on trout to size of adult lamprey population. 3. Analysis of data. Note effect of lamprey reduction on scar and wound index and mortality rates of Lake and Rainbow trout.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0220, TRIBUTARY SURVEY OF LAKES ONTARIO AND ERIE

W.A. PEARCE, State Conservation Department, *Cape Vincent, New York* 13618

Objective: Obtain information on Lake Ontario and Lake Erie tributaries required for an anadromous fish management program.

Procedures: Project personnel will review existing stream data. Streams needing more data will be selected for detailed surveys. Study streams will be mapped for use in identifying areas of special need. A suitable stream survey sheet will be designed that will complement existing forms in use by other agencies such as lamprey control units.

Survey schedules will coordinate with other agencies working on individual streams including lamprey control surveys in May or June, Regional Fish Management surveys, spawning run checks. Study streams must be checked during critical periods of high and low flow, winter ice conditions, times of high water temperatures and irregular flows from hydro-power plant controls. Individual plans for each of the important streams and tributaries include: 1. General physical and chemical data. 2. Barrier sites - both permanent and temporary. 3. Existing and potential salmonid spawning and nursery sites. 4. Potential spawning channel, rearing pond, weir and fish ladder sites. 5. Acquisition needs. 6. Sources of pollution. 7. Regulated flow recommendations where applicable.

An overall tributary plan encompassing individual stream plans will be completed for Lake Ontario. A similar plan will be completed for New York's section of Lake Erie.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0221, PLANNING FOR CREATION OF SALMONID FISHERIES IN LAKE ONTARIO

T.M. JOLLIFF, State Dept. of Env. Conserv., *Cape Vincent, New York*

Objectives: To continue development of a detailed plan for study and development of salmonid fisheries in Lake Ontario.

Procedures: Historically fisheries for lake trout, whitefish, and walleyes were existent in the deeper water of Lake Ontario and for Atlantic salmon in its tributaries. These have declined to the point of disappearance, due, probably, to overfishing of lamprey decimated populations. A great need for redevelopment of fisheries in both deep waters and Lake Ontario tributaries exists. Such refurbishment can probably be carried out with greatest facility by establishment of harvestable (in both commercial and sport senses) populations of salmonids. Species would include rainbow trout, and Atlantic and Pacific salmon. Development will, in turn, hinge upon control of the sea lamprey.

The plan for a five-year program will present the details of four major studies as follows (The plan will be a continuation of planning carried out during a previous Project, AFS-5-1): The monitoring of fish stocks in Lake Ontario before, during and following lamprey control, stocking of salmonids, and establishment of fisheries. The data will: allow evaluation of success of lamprey control, and salmonid stocking, and establihment of fishery parameters in the lake and its tributaries; the development of successful stocking of salmonids from hatchery sources and spawning channels; The evaluation of lamprey control from stream and lake data taken before and after control; Evaluation of the status of forage species in Lake Ontario.

The four studies will, together, provide adequate control of sea lampreys, efficient stocking of salmonids and proper regulations of the resultant fisheries. Activities will include monitoring of lampreys and salmonid stocks in tributaries and open waters by electro-fishing, traps and netting. An index to lamprey scarring will be determined. Population dynamics will be studied and newly established fisheries will be regulated. The plan will be carried out during a combined AFS-DJ study beginning on June 3, 1971. The detailed activities will be correlated with those of other agencies that are actively concerned with the fisheries of Lake Ontario.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0222, PRE-LAMPREY CONTROL INVENTORY OF FISH STOCKS

T.M. JOLLIFF, State Dept. of Env. Conserv., *Cape Vincent, New York*

Objectives: To initiate pre-lamprey control inventory of salmonid and other fish populations in Lake Ontario in order to establish indices to lamprey scarring and baselines with which to measure the future success of sea lamprey control and stocking of salmonids.

To initiate inventory of the extent of rainbow trout migration in Lake Ontario tributaries and their suitability as spawning and rearing streams in order to locate streams in which self-perpetuating runs of salmon and trout might be established.

Procedures: Up to 5 series of gill nets will be set in Lake Ontario in coordination with inter-agency plans. Vital statistics, spacial distribution, abundance on a catch per unit of effort basis, and degree of sea lamprey scarring will be determined for all species of fish. Standardized gill nets will be fished.

The presence of migrating and resident rainbow trout in Ontario tributaries will be determined by electrofishing and from scale patterns. Evaluation of streams will be done from presence of various life history stages of trout, and stream morphology.

This job is prelminary to continued extensive, coordinated inventory of Lake Ontario and its tributaries before, during, and after sea lamprey control, as part of a combined AFS-DJ project.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0223, DEVELOPMENT OF ACCURATE CHEMICAL INTRODUCTION TECHNIQUES

H.A. LOEB, State Conservation Department, *Livingston Manor, New York* 12578

Objectives: To develop accurate, practical methods of introducing chemicals into streams for period of up to 12 hours.

Procedures: Several methods are used to place chemicals in streams. Liquids are introduced in bulk by the slug method, by head changing container, by constant head container and by metered or non- metered pumping. An accurate, constant head, constant flow Mariotte bottle holding up to 13 gallons of solution has been developed. By adjusting various parts the bottle can be emptied in any desired time. A given amount of chemical can be introduced in that period. For example, a 13-gallon bottle will deliver 1 ppm Noxfish to a 40 cfs stream for 12 hours or to a 480 cfs stream for 1 hour. Several bottles would be used in a large stream to assure distribution of toxicant. The bottles would be placed on leveled tripods in the stream or on the stream bank. In the latter case a separate line would be run from each bottle to a release point in the stream. An accurate, constant-flow syphon holding up to 45 gallons of solution is used to introduce chemicals. It will provide 4 ppm of 4.4% solution potassium permanganate to a 22 cfs stream for an hour, or 1 ppm Noxfish to a 1670 cfs stream. For streams larger than about 20 cfs introduction of dry potassium permanganate is necessary; 30, 100 and 1000 cfs streams would require distribution every 5 minutes of 2.25, 7.5 and 75 lbs. respectively.

Hatchery feeders and other devices capable of metering powder or crystals at rates of a fraction of a pound to 15 pounds per minute from loads of several hundred pounds will be studied and tested. Specifications will call for weatherproofing, and line and manual operation. Powder or crystal specifications will be determined. Devices used to scatter potassium permanganate have, to date, experienced weather and flow difficulties.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0224, TIME-CONCENTRATION TESTS INVOLVING NEUTRALIZATION OF ROTENONE WITH POTASSIUM PERMANGANATE

H.A. LOEB, State Conservation Department, *Livingston Manor, New York* 12578

Objective: To develop standard chemical methods of killing fish in defined sections of streams.

Procedure: Laboratory tests show that at 65 degrees F (approximating many summer stream temperatures) 1.0 ppm Noxfish will kill trout in 20 minutes and most other fish in at least several hours (excluding carp, goldfish, and bullheads; the latter two are most resistant). What has become a somewhat standard method is used in many streams; that is, the introduction of 5 ppm Noxfish for 1 hour followed by 1 ppm for 5 hours; this will effectively remove carp.

Potassium permaganate is used to neutralize the Noxfish. Laboratory tests show that 1 ppm Noxfish is effectively neutralized by 3 ppm permanganate in about 17 minutes; the Noxfish is reduced to less than 0.03 ppm, a concentration which will not affect fingerling trout. The two chemicals are placed in jars, the permanganate is neutralized with tannic acid in a sequence of jars at intervals, and the solution is bioassayed.

Neutralization of Noxfish is also affected by natural chlorine demand in a stream. For example, if 1 ppm were to be neutralized and the chlorine demand were 1 ppm, the total permanganate added could be 3 plus 1 or 4 ppm.

Time to neutralization of Noxfish is in inverse proportion to the amount of potassium permanganate present. In effect, the distance between the point where permanganate is introduced and effective neutralization downstream can be cut in half by doubling the concentration of permanganate.

Even 6 ppm of permanganate would be toxic to fish over a period of 6 hours creating a zone of permanganate toxicity below the zone of neutralization. However, tannic acid can be used to neutralize the permanganate. Tannic acid has never been used for this purpose in a stream; 2 ppm will almost instantaneously detoxify 3 ppm of potassium permanganate. The use of tannic acid adds another dimension to the complicated tasks of stream reclamation but is probably practical because it will allow reduction of the zone of neutralization to practical proportions.

The Ten Mile River, a 20 cfs stream in summer, will be used as a test stream. Caged trout bioassay will ascertain the effect of rotenone and points and degrees of neutralization. The bottom of the zone of neutralization will be located by timing the velocity to various points by salt and conductivity meter. (Text abridged).

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0225, NEUTRALIZATION OF ROTENONE WITH ACTIVATED CHARCOAL

H.A. LOEB, State Conservation Department, *Livingston Manor, New York* 12578

Objective: To develop a method of neutralizing rotenone products in streams with powdered, activated carbon.

Procedure: Neutralization of rotenone in streams is desirable for delineation of test sections. Activated carbon would be preferable for neutralization because it is non-toxic.

A range of concentrations of activated carbon will be tested against 1 and 5 ppm of Noxfish for one hour. Effective concentrations will be tested for shorter periods in an attempt to determine the lowest concentration which neutralizes Noxfish (reduce to less then 0.03 ppm) in a practical time of 15 minutes or less.

Five and 20 gallon aquaria will be used in 65 degree F. water baths. Minimum number of fish for final bioassays will be 11. Water will have a range in pH of 6.5 to 7.5.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0226, THE TOXICITY AND DETOXIFICATION OF THE ROTENONE FORMULATIONS USED IN FISH MANAGEMENT

E.H. SHANNON, State Wildlife Resources Comm., *Raleigh, North Carolina* 27602

The objectives of this job are to determine the relative toxicity, constancy, and susceptibility to detoxification possessed by the various commercial rotenone formulations used in fish management and to determine the effects of temperature, water quality, and other pertinent variables upon these factors.

The work scheduled under this job during Fiscal Year 1970 will be, as programmed in the Project Statement, establishment of toxicity and detoxification limits of commercial rotenone formulations under variations of water quality but at a fixed temperature of 68 degrees F. The particular rotenone formulations to be tested include Nox-fish, Pro- Nox-fish, Chem-Fish Regular, Chem-Fish OF, Chem-Fish Synergized OF, Chem-Fish Special OF, Chem-Fish Collector, and Chem-Fish T. The test organisms will be 1- to 2-inch sunfishes.

These studies will be made at the Commission's Fayetteville Water Quality Laboratory.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0227, AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO

F. STEVENSON, State Div. of Wildlife, *Ashley, Ohio* 43003

Objective: The objective of this job is to develop and evaluate experimental management techniques for small impoundments in Ohio. Emphasis will be placed on manipulating pan-fish populations.

Procedures: 1. An evaluation of partial removal of bluegills from six Ohio ponds. Partial shoreline treatment with rotenone will be evaluated to determine the effect of partial removal upon the growth and recruitment of bass and bluegill populations. 2. An evaluation of species combinations and numerical ratios of fish stocking in ponds. Biological, chemical and physical parameters will be measured to determine what factors affect the success or failure of these combinations. 3. Observations will be made to determine the effectiveness of Israeli Carp in controlling various species of vegetation present in the ponds. 4. A Preliminary Evaluation of a Florida Strain of Largemouth Bass (Micropterus salmoides) in Ohio ponds. Growth rates will be determined and compared with native Ohio bass. 5. Potassium permaganate will be applied at varying rates to ponds that are drained down to remove fish to determine its effectiveness in reducing oxygen depletion caused by decomposing organic matter. 6. Ponds to be rehabilitated containing large populations of bullheads will be treated with copper sulfate at rates from 1.0 to 3.0 ppm to determine if the copper sulfate will selectively eradicate bullheads. 7. Experimental Management of Public Ponds. Groups of ponds on public lands are to be set up on a rotation system in which population are to be renewed every three years. 8. A Preliminary Evaluation of the Flathead Catfish as a Predator in Ohio Ponds. Various numbers of 10 to 12 inch flathead catfish will be stocked in over populated ponds to determine if these fish will feed on the intermediate bluegills and thus increase the growth rate of the remaining bluegill population.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0228, PISCICIDE TOXICOLOGY OF THE CYPRINIDS IN EAST AND WEST PAULINA LAKES

J.R. DONALDSON, State Fish Commission, *Portland, Oregon* 97201

Objectives: To determine the toxicity of various piscicides to be used for eventual population control.

Job Objectives: To select and test various concentrations of piscicides on fish and other aquatic fauna.

Procedures: Selected piscicides will be used to determine the toxic concentrations to fish and other aquatic fauna. The work will involve bioassay and field application of rotenone and antimycin (Fintrol). The bioassay work will be under controlled conditions with dissolved oxygen, alkalinity and pH monitored. Optimum kill

$ concentrations for chubs will be determined for these particular lakes. Bioassay work in the other aquatic organisms, at those optimum concentrations, will be conducted at the same time. These data will be used to determine the most effective fish toxicant and the most effective concentrations that can be used on the two lakes. Application of the toxicant to the lake will be rigidly controlled and the effects monitored. The period of toxicity within the lake will be determined. Application will be by means of liquid application or in a sand-grain formulation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0229, EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT)

W. KNISPEL, State Game Commission, *Portland, Oregon* 97208

Objectives: Continue bioassays with antimycin. Determine the correct concentration to use and chemically treat the lake to selectively eliminate yellow perch and the younger age classes of crappie in a mixed population of warm-water game fish.

Procedures: 1. Continue the bioassays on yellow perch, crappie, largemouth bass, carp, and bullhead catfish. 2. Determine the correct concentration of antimycin to selectively control (eliminate) yellow perch and younger age classes of crappie without destroying adult bass and catfish. 3. Recheck pH, TDS, water temperatures and dissolved oxygen in the lake. 4. Chemically treat the lake with antimycin. 5. Live-box perch, bass, and crappie at time of treatment to assess toxicities. 6. Determine success of treatment by sampling the fishery population with hoop, gill, and trap nets and creel census.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0230, EVALUATE FISH TOXICANT (ANTIMYCIN) (EAGLE LAKE SEGMENT)

R. SAYRE, State Game Commission, *Portland, Oregon* 97208

Objectives: Conduct bioassays with antimycin on lake trout and brook trout in Eagle Lake. Determine concentration that is required and chemically treat the lake to remove the existing fish population. Evaluate the success of the program.

Procedure: 1. Conduct bioassays using antimycin to determine the correct concentration of the toxicant. 2. Recheck pH, dissolved oxygen content, and water temperatures of the lake. 3. Live-box fish at time of treatment to determine dispersion and toxicity of material. 4. Check for completeness of kill by setting gill nets after treatment. 5. Continue to monitor success of program after restocking by gill netting and creel census.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0231, MERIDIAN STATE PARK LAKE CRAPPIE REMOVAL EXPERIMENT

C.T. MENN, State Parks & Wildlife Dept., *Austin, Texas* 78701

To evaluate the continuous removal of undersized crappie and to determine the effects of such removal on the crappie population of Medidian State Park Lake. Procedures: A 1-year creel census will be completed this segment. Creel census will be conducted on a 7-day week every-other-week basis.

Crappie removal will begin this segment and continue until 5 pounds per acre have been removed from this 80-acre lake. Nets and traps will be used and evaluated in the process to test the effectiveness of various methods of removal.

Largemouth black bass and channel catfish will also be tagged and returned to the lake to determine if these species are affected by the crappie removal.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0232, FISH TOXICANT STUDIES

R.L. WHITE, State Parks & Wildlife Dept., *Austin, Texas* 78701

Objective: To test the effectiveness and desirability of anhydrous ammonia for the total elimination of fish populations.

Procedures: Anhydrous ammonia will be screened in literature, in the laboratory and in the field to determine its effectiveness as a fish toxicant. Application techniques, species selectiveness, duration of toxicity and overall effectiveness will be of prime concern in this study.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0233, EFFECTS OF METHOXYCHLOR ON THE CONDITIONING OF STRIPED BASS TO AN OLFACTORY STIMULUS

J.A. MUSICK, Virginia Inst. of Marine Sci., *Gloucester Point, Virginia* 23062

Three groups of striped bass will be used--one control and two experimental groups. The two experimental groups will be exposed to concentrations of 5 and 10 ppb methoxychlor. One-half of each group will be positively-conditioned to the introduction of an odor. The odor half will be negatively-conditioned. Differences in response to the stimulus and time required for conditioning will be looked for. Some histological work may be done.

SUPPORTED BY Virginia Inst. of Marine Sci. - Virginia

2.0234, EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES

G. WEDEMEYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle, Washington* 98115

In the higher vertebrates, anesthetics such as diethyl ether have been shown to cause profound metabolic changes due to pituitary activation while anesthetics such as the barbituates do not. Since biomedical research on fishes frequently requires anesthesia prior to blood sampling, the effects of the anesthetic agent itself on the normal blood chemistries should be understood.

MS-222, methyl pentynol, CO2, benzocaine, ether and 2 phenoxyethanol will be investigated using rainbow trout as the test fish. Liver function will be evaluated using alkaline phosphatase, glucose, BUN, bilirubin and SGOT; the acid base balance by Cl minus and kidney function by creatinine measurements.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0235, POPULATION DYNAMICS - LAKE TROUT

R.L. PYCHA, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Ashland, Wisconsin* 54806

The sea lamprey control program cannot be thoroughly evaluated until various indices of lamprey abundance and predation can be expressed directly in terms of lake trout mortality. Determination of lake trout mortality due to sea lampreys, normal natural mortality, and fishing mortality (commercial and sport) at the present level of lamprey abundance and fishing intensity is the most immediate objective of research in Lake Superior. Determination of the necessary size of spawning stock and levels of natural reproduction of lake trout are necessary for determination of recruitment. Mortality, recruitment, and growth data will be used to determine the available sustainable yield. Providing sustainable yield information to state management agencies and the Great Lakes Fishery Commission is necessary for re-establishment of a viable lake trout fishery. Collection of information on interspecies relationships and environmental changes is a continuing objective that is valuable for evaluating future changes in the lake.

2. AQUATIC PEST CONTROL

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0236, RESIDUES OF MS-222 IN FISH

J.L. ALLEN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

MS-222 (methanesulfonate of ethyl m-aminobenzoate), an anesthetic for fish, has not been cleared for use on fish by the U.S. Food and Drug Administration. The requirements for clearance include information on residues of the drug in fish tissue.

Selected fish are exposed to effective concentrations of MS-222, and recovered in fresh water. Samples are withdrawn at selected intervals, and analyzed for free and acetylated MS-222 residues by the Bratton-Marshall method confirmed by thin layer chromatography.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0237, U.V. SPECTROPHOTOMETRY FOR THE IDENTIFICATION AND ESTIMATION OF QUINALDINE RESIDUE

J.L. ALLEN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Quinaldine and quinaldine sulfate are used as fish anesthetics, but have not been cleared for this use by the Food and Drug Administration. The requirements for clearance include two methods of residue analysis, preferably using entirely dfferent model of analysis.

A gas chromatographic method has been developed for the analysis of quinaldine residue in fish. As a second method, U.V. spectrophotometry appears to have the needed sensitivity, and also shows the spectrum for identification. Precedures for sample preparation, clean up and analysis by U.S. spectrophotometry must be developed. Fish are treated with quinaldine and quinaldine sulfate, and attempts are made to extract, clean up, and detect quinaldine in the extracts by U.V. spectrophotometry.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0238, THE DEVELOPMENT OF ANALYTICAL METHODS CAPABLE OF MEASURING TFM RESIDUES IN FISH, WATER, AND OTHER COMPLEX SUBSTRATES

J.L. ALLEN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

TFM (3-trifluoromethyl-4-nitrophenol) is an effective agent for control of sea lamprey. The registration of this control agent is dependent partially on the development of a method capable of measuring TFM residues. Gas chromatography appears to be a sensitive and selective method which could be applied to the analysis of complex substrates for TFM residues. Methodology must be developed for the extraction clean up and chromatography of samples for TFM residue analysis. Fish are exposed to TFM and attempts are made to extract, clean up and detect TFM in the extracts by gas chromatography.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0239, THE EFFICACY OF QUINALDINE SULFATE - MS-222 AS AN ANESTHETIC FOR FISH IN THE LABORATORY - WARM SPRINGS

J.L. ALLEN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Quinaldine sulfate and MS-222 (tricaine methanesulfonate) are fish anesthetics. Recent investigations indicate that mixtures of the two compounds possess enhanced anesthetic activity. New or improved anesthetics must meet legal requirements for efficacy prior to use in the field. A necessary step in the development and registration of quinaldine sulfate: MS-222 is a thorough evaluation of its efficacy and safety on fish.

Various proportions of quinaldine sulfate and MS-222 in mixtures are tested in the laboratory to define concentrations that are effective in anesthetizing channel catfish, largemouth bass, bluegill and grass carp (white amur).

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0240, SELECTIVE REMOVAL OF VARIOUS FISH SPECIES WITH ANTIMYCIN

B.L. BERGER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Antimycin (Fintrol) as evaluatd in the laboratory and outdoor pools demonstrated potential as a selective control agent by manipulating concentrations or selective applications. Field studies are necessary to determine efficacy in large bodies of water considering light, water quality and temperature.

Investigations are conducted in an effort to control or manipulate game fish populations such as bluegills, largemouth bass, and yellow perch in relation to other fishes. Minimal concentrations are to be applied to young-of-the-year in the presence of adults of the same species. Chemical application in specific spawning or habitat sites may offer partial control amongst different species. Applications are made to hatchery ponds and natural lakes and streams. Degradation and residual effects are investigated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0241, INTENSIVE SCREENING OF POTENTIAL FISH CONTROL AGENTS - POTENTIATION OF ANTIMYCIN

B.L. BERGER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

The potentiation of antimycin is desirable to make it a more effective control agent at lower concentrations against resistant species such as the catfishes.

Compounds selected for this potentiation or synergization are chosen by literature review, testing of formulations and mode of action studies. Their effectiveness is to be checked by bioassay and analytical methods.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0242, THE EFFICACY OF THANITE (ISOBORNYL THIOCYANOACETATE) AS A FISH COLLECTION AID

R.M. BURRESS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

In 1968, the use of Thanite, an insecticide of low mammalian toxicity, was proposed as a safe and effective aid for live collection of fish. There is need, however, to evaluate its efficacy under different ecological conditions. Field tests will be conducted throughout the year in selected ponds in several locations to determine the influence of various physical and chemical parameters upon the efficacy of Thanite for fish collection, and to measure the degree of selective toxicity manifested against a wide variety of fishes.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0243, THE EFFICACY OF MONSANTO NO. 51294 AS A FISH TOXICANT (LABORATORY)

V.K. DAWSON, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Monsanto No. 51294 is a candidate general fish toxicant. It is highly toxic to a wide variety of cold- and warm-water fish, including bullheads and carp. The toxicity is not influenced greatly by different chemical and physical properties of the water. A necessary step in the development and registration of Monsanto No. 51294 is a thorough evaluation of its efficacy on target fish.

The toxicant is subjected to trials in laboratory water and pond water to establish concentrations that are effective in killing target species of fish. Several life stages of selected fishes are exposed to lethal concentrations of the toxicant in waters of different temperature, pH and hardness. Additional tests, in static or continuous flows, may demonstrate the persistence of the toxicant in water, the time required for detoxification, methods for artificial degradation, the long-term effects on growth and reproduction, and the effects on other organisms. The data are evaluated to determine whether the candidate warrants further research and development as a fish toxicant.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0244, THE EFFICACY AND PERSISTENCE OF FORMULATIONS OF ANTIMYCIN

V.K. DAWSON, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Antimycin has been used extensively as a general fish toxicant, but offers potential for selective removal of target species. It is highly toxic to a wide variety of cold- and warm-water fish, however, chemical and physical properties of the water influence the efficacy, persistence, and economics of the toxicant. New formulations of antimycin are being developed for specific treatment purposes. A necessary step in the development and registration of antimycin is a thorough evaluation of the efficacy of the formulations and the persistence of antimycin under various conditions.

The toxicant formulations are subjected to trials in laboratory water and pond water to establish applications that are effective against target species of fish. The persistence and rate of detoxification under various conditions of temperature, pH, water hardness, and exposure to sunlight are determined with fish bioassay and fluorometric analysis. Methods of artificial degradation of antimycin are assessed and the data are evaluated to determine the usefulness of new formulations and the fate of the toxicant in the environment.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0245, DEVELOPMENT OF RHODAMINE-B DYE TO TRACE FLOW AND DISPERSION PATTERNS IN STREAMS AS AN ADJUNCT TO TREATING STREAMS WITH FISH-CONTROL CHEMICALS

P.A. GILDERHUS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

The removal of fish with toxicants is one of the important tools available to fishery workers for managing streams. The dispersion and dilution patterns vary considerably according to the physical characteristics of the stream. In order to maintain the proper concentration for the proper length of time in a stream, the worker must have a knowledge of the dispersion patterns in that particular stream. Applications of dyes are made for different lengths of time in different types of streams and in flowing water facilities in the laboratory and the dispersion characteristics are evaluated by fluorometric analysis for the dye.

Specifically, the experiments are designed to evaluate the dye as a tracer and to define parameters such as how long the dye must be applied to give a true estimate of the dispersion of an extended application of toxicant, where the dye must be applied to accurately predict where and how much a slug of toxicant must be fortified to maintain the proper concentration, and generalized formulae based on the physical characteristics to define the dispersion characteristics in different types of streams.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0246, THE EFFICACY OF NEW FORMULATIONS OF ANTIMYCIN IN NATURAL LAKES AND STREAMS

P.A. GILDERHUS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

The successful reclamation of natural waters with toxicants is dependent upon the proper formulations and application techniques to facilitate an adequate distribution of the chemical. In streams, problems arise from the need for sustained application at many different points at the same time to maintain a concentration in the moving water. In lakes, it is necessary to get an even distribution of chemical both horizontally and vertically in the target body of water.

The manufacturer of antimycin has developed a solid bar formulation which, when suspended in a stream, will dissolve at a constant rate over a period of several hours. They also have developed a deep-water granular formulation for use in lakes up to 30 feet or more deep. This formulation is designed to release the chemical evenly as it sinks to the bottom. Tests are conducted to determine the efficacy of these formulations in appropriate natural waters. Special attention is given to the influence of water quality and temperature on the efficacy of these formulations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0247, ESTABLISH MINIMUM DOSES OF ANTIMYCIN AND ROTENONE NEEDED FOR TOTAL KILLS OF TARGET FISHES

P.A. GILDERHUS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

The elimination of undesirable species of fish with toxicants requires that target fish be exposed to a particular concentration of a toxicant for a particular length of time (Concentration plus exposure equals dose). The length of exposure is particularly critical in flowing water where the toxicant moves past the fish, or in water where the toxicant is likely to undergo rapid natural degradation.

Experiments are conducted in a flowing-water system. A selected concentration of the toxicant is metered in at a constant rate. Fish are exposed to the toxicant for selected periods of time, after which they are moved to flowing, untreated water for observation. Tests are designed to define the length of time a particular species must be exposed to a particular concentration of antimycin or rotenone to incur 100 percent mortality within 96 hours after the beginning of their exposure.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0248, DEVELOPMENTS OF METHODS RELATED TO TESTING OF FISH CONTROL AGENTS BIOCHEMICAL METHOD FOR SEXING FISH

J.B. HUNN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Sexing of various species of fish (gar, largemouth bass, etc.), now being raised for research, is difficult when using only external physical characteristics. It has been established that both female fish and birds produce a lipophosphoprotein in the liver during egg development which is transported to the ovary via the blood. The highest blood levels of this protein are found prior to egg laying. This plasma protein complex will precipitate when diluted with distilled water (1:5 to 1:9). No such protein is produced in the male under normal conditions.

Blood samples will be drawn from mature, pre-spawning fish and analyzed for hematocrit and lipophosphoprotein to determine the sex of the fish. Autopsy will be used to confirm the accuracy of this testing procedure.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0249, ROUTE(S) OF EXCRETION OF QUINALDINE SULFATE, A FISH ANESTHETIC

J.B. HUNN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Quinaldine sulfate itself or in combination with MS-222 is an effective anesthetic for a number of species of fish. Residues of quinaldine are rapidly eliminated from fish usually within 24 hours of recovery in fresh water. However, the routes and relative rates of excretion of this compound have yet to be established.

Rainbow trout are anesthetized with MS-222, catheterized and placed into a urine collecting apparatus. Following recovery, trout are re-anesthetized with quinaldine sulfate or a combination of quinaldine sulfate and MS-222 and urine is collected at various intervals following anesthesia. Residues of quinaldine are determined using a fluorometric or ultraviolet method of analysis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0250, IN VIVO AND IN VITRO STUDIES ON THE MODE OF ACTION OF TFM

J.B. HUNN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Studies by investigators in the Department of Pharmacology of the Medical College of Wisconsin suggest that the action of TFM (3- trifluoromethyl - 4-nitrophenol) in mammals may be mediated via catecholamines.

Non-target fish, rainbow trout, and brown trout will be injected with drugs that block the action of catecholamines. Trout are exposed to lethal concentrations of TFM and effects of catecholamines inhibition measured. Tissues from injected trout are exposed to various concentrations of TFM in vitro to assess the direct effects of TFM.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0251, METABOLISM AND EXCRETION OF TFM

J.B. HUNN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Biotransformation of TFM (3-trifluoromethyl-4-nitrophenol) in rats takes place via reduction, sulfation, glucuronidation and possibly acetylation. We have previously shown in this laboratory that rainbow trout reduce and acetylate the primary amine of MS-222. Non-target fishes, rainbow trout and carp, are exposed to TFM and the routes and rate of excretion determined.

Tissues from the above non-target species are incubated with TFM to study the pathways for biotransformation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0252, THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES

J.B. HUNN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

TFM (3-trifluoromethyl-4-nitrophenol) has proven an effective control chemical on larval sea lamprey in freshwater streams. The effects of TFM on non-target fishes have been little studied although it has been suggested that TFM may have effects similar to other nitrophenols.

To test this hypothesis, non-target fishes such as rainbow trout, brown trout, white suckers, carp and northern pike are exposed to TFM. Blood samples are taken after various intervals of exposure and analyzed for Na, K, Ca, Mg, lactic acid, glucose, and pH.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0253, THE EFFECTS OF THANITE ON THE INORGANIC BLOOD CHEMISTRIES OF FISHES

J.B. HUNN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Thanite (isobornyl thiocyanoacetate) is a potential fish-collecting aid due to the surfacing action elicited in fish. An evaluation of the mode of action and its reversibility is needed before Thanite can be used safely in the field. One action of cyanide is the reversible inhibition of cellular oxidizing enzymes containing iron. Laboratory measurements of blood cations are needed to determine the severity and reversibility of any ionic imbalance due to enzymatic inhibition.

Blood samples of selected species of fish are analyzed for iron, calcium, magnesium, sodium, and potassium during exposure to and recovery from the action of Thanite.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0254, THE EFFECTS OF THANITE ON THE ACID-BASE BALANCE IN THE BLOOD OF FISHES

J.B. HUNN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Thanite, an organocyanide compound, shows promise as a fish collecting aid because an effective concentration causes them to surface. It is known that cyanide produces a cytotoxic anoxia by reversibly inhibiting cellular oxidizing enzymes containing iron in the ferric state. Laboratory studies are needed to determine the extent of acid-base disturbances that fish can tolerate during their exposure to and recovery from the action of Thanite.

Susceptible and resistant species such as rainbow trout and carp are exposed to effective concentrations of Thanite. Effects on acid- base balance are determined by measurements of pH, total CO_2, pCO_2, and lactic acid concentrations in the blood.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0255, STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES

L.L. MARKING, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Fish toxicants for the control of undesirable fishes are required by fishery managers and fish culturists. The toxicants must be safe to man and non-target organisms, specific to target species, and nonpersistent in the environment. A substantial number of toxicants with distinctive characteristics and formulations are needed by fishery managers and fish culturists to achieve total, or selective control of problem fishes in: (1) marine or fresh waters, (2) hard or soft waters, (3) cold or warm waters, (4) high or low pH waters, (5) turbid or clear waters, (6) shallow or deep waters, and (7) polluted or non-polluted waters.

Potential fish toxicants are subjected to short-term (acute), static bioassays to determine concentrations that are lethal to 1- to 3- in. and 1- to 3-gram rainbow trout, goldfish, carp, white suckers, black bullheads, green sunfish, bluegills, yellow perch and other selected species. Additional bioassays are conducted to determine lethal concentrations (LC50's) for the toxicants against selected species of fish, fish eggs and aquatic invertebrates in waters of different pH, water hardness, and temperature. Additional bioassays may demonstrate the persistence of the candidate toxicant in water, and the effects on other selected organisms within the environment. Following the bioassays, the potential of a compound for further development as a fish toxicant is evaluated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0256, STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES

L.L. MARKING, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Fishery managers and fish culturists desire means to limit the reproduction of fish. Some chemicals cause sterility in fish, but much research remains to be done. Possibilities may include sex reversal in adult or juvenile fish, or sterilization of fish by means of hormones, chemosterilents, or radiation. Some chemicals inhibit the growth and development of fish eggs.

A primary step in the development and registration of a reproductive control is a thorough evaluation of its toxicity. Candidate reproductive controls are found in the literature or referred to us by fish culturists and pathologists. Standard bioassay methods are used to establish concentrations that are toxic and nontoxic to selected species of fish. Lethal concentrations (LC50's) are derived for selected life stages of fish in waters of different temperature, water hardness, and pH. Additional bioassays may demonstrate the persistence of the candidate reproductive control in water, the safety index, and the effect on other organisms within the environment. The toxicity established at various exposures influences the selection of concentration to prove efficacy. The results indicate whether the candidate control warrants further development as a tool for fishery management.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0257, STATIC BIOASSAY OF COLLECTING AIDS AGAINST FISH

L.L. MARKING, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Fishery managers, fish culturists, and fish farmers need chemical aids that can be employed effectively and economically for the collection of live fish. A collecting aid should cause involuntary surfacing, reduced mobility, or stupefaction in fish, the aid should act rapidly and allow recovery of the fish, and it should be safe and nonpolluting in the environment. A primary step in the development and registration of a collecting aid is a thorough evaluation of its toxicity (safety) to fish.

Candidate collecting aids are recognized in bioassays or found in reviews of the literature. Standard bioassay methods are used to establish lethal and nonlethal concentrations for selected species of fish. Lethal concentrations (LC50's) are derived for selected life stages of fish in waters of different temperature, water hardness, and pH. Additional bioassays may demonstrate the persistence of the chemical in water, and the effects on other organisms within the environment. The data on toxicity indicate whether the chemical warrants further development as a collecting aid.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0258, STATIC BIOASSAY OF ATTRACTANTS AND REPELLANTS AGAINST FISH AND INVERTEBRATES

L.L. MARKING, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Fish managers, fish culturists, fish farmers and others require means to attract or repel fish. Chemical attractants or repellants may be employed in harvesting fish, in directing the migration of fish away from irrigation ditches or hydroelectric hazards, and in conjunction with toxicants or collecting aids in achieving control of rough fish. A primary step in the development and registration of an attractant or repellant is a thorough evaluation of its toxicity (safety) to fish.

A candidate attractant or repellent is recognized in bioassays or in reviews of the literature. Standard bioassay methods are used to establish lethal and nonlethal concentrations for selected species of fish. Lethal concentrations (LC50's) are derived for selected life stages of fish in waters of different temperature, water hardness, and pH. Additional bioassays may demonstrate the persistence of the chemicals in water and the effects on other organisms within the environment. Special testing apparatus may be employed to further evaluate the toxicity and prove efficacy. The data on toxicity indicate whether the candidate warrants further development as a fish attractant or repellant.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0259, CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES

L.L. MARKING, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Fish toxicants for the control of undesirable fishes are required by fishery managers and fish culturists. The toxicants must be safe to man and non-target organisms, effective on target species, and nonpersistent in the environment. A substantial number of toxicants with distinctive characteristics and formulations are needed by fishery managers and fish culturists to achieve total, or selective control of problem fishes in: (1) marine or fresh waters, (2) hard or soft waters, (3) cold or warm waters, (4) high or low pH waters, (5) turbid or clear waters, (6) shallow or deep waters, and (7) polluted or non-polluted waters.

Potential fish toxicants are subjected to short-term (acute), continuous flow bioassays to determine concentrations that are lethal to rainbow trout, goldfish, carp, white suckers, black bullheads, green sunfish, bluegills, yellow perch and other selected species of fish. Additional bioassays are conducted to determine lethal concentrations (LC50's) of the toxicants against selected species of fish, fish eggs and aquatic invertebrates in waters of different quality and temperature. Additional bioassays may demonstrate the persistence of the candidate toxicant in water, the long-term (chronic) toxicity to fish, and the effects on other selected organisms within the environment. Following the bioassays, the potential of a compound for further development as a fish toxicant is evaluated.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0260, EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH

R.A. SCHOETTGER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

The literature shows that antimycin A is a strong inhibitor of electron transport in the oxidative-phosphorylation system. Preliminary research indicates that a major physiological effect of antimycin on fish is a disruption of acid-base balance. Laboratory studies are needed to determine whether the effect is different in different species, and whether the concentration of the bicarbonate ion in the external environment may influence the physiological effects of antimycin.

Resistant and susceptible species such as channel catfish and rainbow trout respectively are treated with antimycin. Effects on acid- base balance are determined by measurements of pH, and CO2 and lactic concentrations in the blood. Hematological parameters are measured in fish which are exposed to antimycin in waters of different qualities.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0261, THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV)

R.A. SCHOETTGER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

Anesthetics are used widely in the culture and management of sport and commercial species. Laboratory tests of potential anesthetics are needed to define effective and safe concentrations which may be employed to facilitate the handling or transport of fish.

The chemical is tested on selected species such as rainbow trout, brown trout, brook trout, lake trout, channel catfish, bluegill, and largemouth bass. Concentrations and exposure times for desired depths of anesthesia are determined. Recovery time is recorded for brief and extended periods of anesthesia. The tests are conducted at 7,12,17,22 and 27 degrees C. The influences of pH, water hardness, size of fish, and repeated anesthetization on the efficacy of McN-JR-7464 are measured. Anesthetized fish are recovered in fresh water and held for several weeks to observe post-treatment mortality, general condition and appetite. They are also given periodic hematological examinations. The toxicity of the compound to reproductive products of fish is determined.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0262, THE EFFECTS OF ANTIMYCIN A ON THE METABOLISM OF SELECTED TISSUES IN FISH (ABBREV)

G.E. SVENDSEN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *La Crosse, Wisconsin*

The literature indicates that antimycin A is a strong inhibitor of electron transport in the oxidative phosphorylation system. The tissues or organs of fish which are affected by the chemical, however, have not been distinguished. Laboratory tests are needed to determine whether the effects of antimycin are general or specific to certain tissues, and whether they differ according to species susceptibility or method of treatment.

Resistant and susceptible species such as bullhead and rainbow trout respectively are treated with antimycin A by IP injection or by exposing them to solutions of the toxicant. After various periods of exposure, treated and control fish are killed and various tissues, for example, gill, brain, liver, kidney and muscle are dissected. The metabolic rates of tissues, measured manometrically, are used to evaluate the effects of antimycin. The results are compared with in vitro effects of antimycin on tissue metabolism.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0263, EXPERIMENTAL RECLAMATION OF TROUT STREAMS THROUGH CHEMICAL TREATMENT

E.L. AVERY, State Dept. of Nat. Resources, *Madison, Wisconsin* 53701

Objective: Determine the degree of improvement that occurs in trout fisheries in chemically reclaimed streams as a result of eliminating or drastically reducing competitor and/or predator species of fish.

Procedures: Job 105.1 - Survey various trout streams throughout the state after consulting with management personnel, and select 2 or 3 streams suitable for intensive study. Job 105.2 - Determine the standing crops by number and weight, survival, growth, and condition factors at least twice annually for each age group of trout for 2 years prior to chemical treatment and 2-3 years after treatment. Job 105.3 - Determine the standing crops by species, number and weight of all major species of fish, other than trout, that can be adequately sampled, and relate the presence or absence of these potential competitors or predators to the trout carrying capacity and trout fishery before and after chemical treatment.

Job 105.4 - Determine changes in number, weight, and kinds of benthic and drift invertebrates that constitute potentially important food resources for trout after competition for these forms has been eliminated or greatly reduced by chemical treatment. Job 105.5 - Determine the angler harvests and exploitation rates of trout in study streams before and after chemical reclamation.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0264, ASSESSMENT OF LAKE TROUT AND ASSOCIATED SPECIES IN LAKES MICHIGAN AND SUPERIOR

R. POFF, State Dept. of Nat. Resources, *Madison, Wisconsin* 53701

Objectives: Primary objective is to determine and develop management techniques that will reestablish lake trout and allied species in sufficient numbers to permit sustained commercial fishing. Studies will include: (1) Effectiveness of lamprey control. (2) Appraisals of stocking and natural reproduction. (3) Trout Ecology. (4) Stocking - Harvesting Relationships. (5) Growth and Maturity. (6) Appraisals of commercial and sports fisheries harvests.

Procedures: Systematic collection of data from cooperators and and contract data from contractors and coordinators and from the direct collection of project personnel.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0265, CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS

F.M. STRONG, Univ. of Wisconsin, Agricultural Experiment Sta., *Madison, Wisconsin* (WIS01409)

OBJECTIVE: Reasons for relative insensitivity of bullheads and catfish to antimycin. Occurrence of 3-methyl-2-hexenoic acid in sweat of schizophrenic and normal persons. Differentiation factors for Ceratocystis ulmi.

APPROACH: Fish are placed in water containing desired concentrations of H-randomly labeled antimycin and their tissues later monitored for H distribution. Bioassay of antimycin after exposure to homogenates of various fish tissues is used to reveal degradation and/or binding of the antibiotic. A liver esterase which inactivates antimycin is being purified. Gas chromatographic analysis of the acid fraction of human sweat is being used to determine whether 3-methyl-2-hexenoic or other acids are characteristically produced by schizophrenics and not by normal persons. Laboratory cultures of Ceratocystis ulmi (causative agent of Dutch Elm Disease) produce coremia in the presence of elm bark extract. The active substance(s) is being purified and identified.

SUPPORTED BY Wisconsin State Government - Madison

2D. SNAILS AND OTHER AQUATIC PESTS OR PREDATORS

(Control of Marine Mollusks, Freshwater or Land Snails, Bird or Mammal Predators)

2.0266, CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES

B. GILBERT, Univ. Do Brasil, *Rio De Janeiro, Brazil*

To study chemical factors involved in the life cycles of schistosoma mansoni and trypanosoma cruzi and their vectors and, based on knowledge of thesd, develop prophylactic methods in schistosomiasis and chagas' disease. This study is designed to increase effectiveness prophylaxis against or treatment of schistosomiasis, a medical problem of major concern to the U.S. Armed Forces when operating in endemic areas of the world.

By the use of chromatography, factors involved in growth and reproduction of s. mansoni, t. cruzi, and their vectors, will be isolated. Terpenes and other natural products, and synthetic hormones will be tested for activity in the same parasites and vectors (See Report No. 4, Grant DAHC19-69-G-0016).

Eleven terpenoids have been shown to inhibit skin penetration by schistosome cercariae (J. Parasitol. 1970, 56,397 and report cited). Transformation of cercariae to schistosomules is trigered by a phospholipid. Growth inhibition by crowding of the snail vector biomphalaria glabrata has been shown to be related to diminished iron uptake. A residual molluscicide based on tributyltin oxide has been developed (Reports Nos. 3 and 4 OF Grant cited). The use of an insect juvenile hormone has been shown to inhibit adult development in rhodnius neglectus, a vector of t. cruzi.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0267, EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE

H.P. VIND, U.S. Navy, Civil Engineering Lab., *Port Hueneme, California*

Objective: Evaluate paraffinic waxes and other saturated hydrocarbons as agents for preventing bleeding and leaching of wood preservatives from marine timbers.

Approach: Small specimens of wood impregnated with various mixtures of creosote and paraffinic hydrocarbons were placed in sea water aquaria well stocked with marine borers of the species Limnoria tripunctata. The times required for the marine borers to sever the specimens of wood were employed as measures of the effectiveness of the preservative mixtures.

The evaluation of mixtures of various petroleum products and cresote as preservatives for marine timbers was completed in Fy 68. The petroleum products had only minor influence on preservative quality. The draft of a technical note describing the investigation has been written and is now being reviewed.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0268, BIOLOGY AND CONTROL OF SNAILS

G.E. CARMAN, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-1417)

OBJECTIVE: Develop more effective and practical means of control of the European brown snail.

APPROACH: Emphasis will be placed on an extensive laboratory screening program to determine the relative toxicity of candidate materials to the snail when ingested and when applied as contact poisons and on the subsequent field evaluation of promising materials. In support of these studies and as background for the development of other means of control investigations concerning the biology and behavior of this snail species will also be undertaken.

PROGRESS: Field trials were undertaken to determine the utility of low volume concentrate spray applications for the control of the European brown garden snail, Helix aspersa Miller, on citrus. Azinphosmethyl used at the rate of 2 pounds actual per acre in 100 gallons per acre as a concentrate spray was as effective as the same amount of toxicant applied manually as a dilute spray (500 gallons per acre). Concentrate spray applications of azinphosmethyl ranging from 0.5 to 4.0 pounds actual per acre demonstrated only a limited tendency for improved control as the dosage was increased. Continuing field tests with the carbamates Mesurol(Reg), methomyl, and carbofuran applied as baits demonstrated their relatively high effectiveness when formulated with either apple pomace or bran substrates. Over 200 candidate molluscicides were screened in the laboratory. Compounds NIA 15267, Hercules 19223, American Cyanamid EM-72613 and Lovozol(Reg) demonstrated sufficient promise to justify involvement in preliminary field trials.

SUPPORTED BY California State Government - Sacramento

2.0269, BIOLOGICAL CONTROL OF SNAILS AND SLUGS

T.W. FISHER, Univ. of California, Agricultural Experiment Sta., *Riverside, California* 92502 (CA-R0-SSE-2037)

OBJECTIVE: Investigate biological control of common garden slugs and snails, Helix aspersa in particular, and aquatic snails which are intermediate hosts of the trematode Fasciola hepatica, or liver fluke of livestock.

APPROACH: Determine the distribution of the pests and their natural enemies. Assess the level of natural control as it now exists in Calfornia. Search for natural enemies, their importation, mass- production, and colonization. Evaluation of importations.

PROGRESS: Feeding tests with Marisa cornuarietis indicated it will consume four species of common aquatic weeds and will consume submerged young rice seedlings. This aquatic snail feeds actively at water temperatures above 70 F. At 60 F it is sluggish and prolonged exposure to 50 F is fatal. Because of prevailing water temperatures in rice growing areas of California and the method of culture (periodic dry periods), it is doubtful that Marisa would pose a threat to the rice industry in this state. This species is of tropical origin and must have warm water continually to do well. In this sense it may hold potential for control of aquatic weeds in warm springs and streams. A periodic release program will be necessary to utilize the species for weed control in desert ponds, because of occasional periods of too low temperature. Field survey and taxonomic studies with the Sciomyzidae (Diptera) over the past six years provides a firm base for planned ecological studies in the field.

SUPPORTED BY California State Government - Sacramento

2.0270, SCHISTOSOME CONTROL BY TREMATODE ANTAGONISM

K.J. LIE, Univ. of California, School of Medicine, *San Francisco, California* 94112

Dispersal of eggs of 'Echinostoma malayanum' into a pond resulted in control of infection of 'Schistosoma spindale' in the snail Indoplanorbis exustus. Control was achieved by three means: 1. Trematode antagonism; 2. Microsporidian epidemic. Considerable increase of trematode infection among the snails was associated with a microsporidian epidemic, affecting the trematode larvae and leading to suppression of cercarial production. The hyperparasite was 'Perezia helminthorum'; 3. Considerable decrease in the snail population due to parasitic castration and a high mortality among infected snails. The most important factor in the control of 'S. spindale' was probably trematode antagonism. This type of biological control is self limiting. The dominant parasites control the subordinate ones, but ultimately they also control themselves by inducing a microsporidian epidemic and by causing a considerable decrease in the snail population. Attempts are now being made to repeat the experiment on a large scale and also to use other combinations of parasites which show antagonism of higher efficiency.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

2.0271, NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM)

C.L. MACKENZIE, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Milford, Connecticut* 06460

Because of a scarcity of seed oysters in Long Island Sound, more efficient control of predators and competitors becomes imperative.

Control of oyster drills and starfish has been achieved. To make control methods more efficient, however, we are presently studying various aspects of the biology of both predators. Particular emphasis has been placed on studying feeding rates of each at various salinities and temperatures, and also on the behavior of these and other enemies on oyster beds as observed by SCUBA divers.

Divers have observed that young starfish hid underneath shells during the day. We are presently attempting to determine the reason they do this.

To better equip the shellfish producer to apply more efficient control methods for Stylochus, Crepidula and barnacles, the principal competitors of oysters, we plan to study various stages of their life cycles.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0272, EVALUATION OF WATERFOWL PREDATOR CONTROL METHODS

C.A. LESSER, State Div. of Fish & Wildlife, *Dover, Delaware* 19901

Objectives: To control waterfowl predators and determine effects on waterfowl production.

Procedures: Live traps and steel traps will be utilized to trap mammals on the study area. All animals captured in live traps will be transferred to areas with depleted populations or destroyed. Records of catches will be kept to determine the most efficient trapping methods. Snapping turtles will also be controlled by commercial trappers utilizing baited hooks and baited pots. Hourly personnel will be hired to assist in mammal trapping.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0273, SEA NETTLE STUDIES IN CHESAPEAKE BAY, LIFE HISTORY AND ECOLOGY

L.P. SCHULTZ, Smithsonian Institution, *Washington, District of Columbia* 20560

The purpose of this study is to find out as much as possible about the life history and ecology of the summer sea nettle (Chrysaora) in Chesapeake Bay with the view to eventually controlling its abundance.

SUPPORTED BY Smithsonian Institution

2.0274, EXPERIMENTS TO RE-ESTABLISH HISTORICAL OYSTER SEED GROUNDS AND TO CONTROL THE SOUTHERN OYSTER DRILL

J.F. POLLARD, State Div. of Oysters, *Baton Rouge, Louisiana*

Objectives: To test various materials to determine which is best suited for use as cultch and to determine through cultch plantings which areas are suitable for re-establishing pre-existing oyster seed grounds. To determine a feasible method of controlling the intrusion of the Southern oyster drill in areas east of the Mississippi River.

Procedures: Experimental plantings of cultch material will be made to determine spat set, growth, and production. Various types of cultch material will be used to determine which yields the best spat set. An attempt will be made to outline the present natural seed area free of the oyster drill. Introduction of fresh Mississippi River into the saline waters will be evaluated, to see if it reduces the damage caused by the oyster drill.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

2.0275, EFFECTS OF WATER EXCHANGE AND BLUE CRAB CONTROL ON SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IMPOUNDMENTS

C.D. ROSE, Francis T. Nicholls State Coll, Graduate School, *Thibodaux, Louisiana* 70301

This project continues the research begun two years ago at Nicholls State College to determine the feasibility of growing shrimp in artificial impoundments in the Louisiana marshlands. During the first two years it was shown that simple management of the impoundments could produce a crop nine times as valuable as that growing in an unmanaged impoundment. The current project will attempt to determine the effect of water exchange in the impoundment and show predator (blue crab) control. Two ponds will be utilized, one receiving tidal flow, the other lacking tidal flow to determine the effect of water exchange. Another impoundment will be divided into fifteen natural bottom enclosures, each measuring 2,500 square feet to ascertain the effect of crab control. In addition, three outdoor spawning impoundments containing adult shrimp will be heated during the winter to determine if spawning can be induced in a semi-natural marsh enclosure by temperature manipulation.

2. AQUATIC PEST CONTROL

SUPPORTED BY U.S. National Science Foundation

2.0276, THE BIOLOGY AND CONTROL OF THE SNAIL INTERMEDIATE HOST OF SCHISTOSOMES

C.S. RICHARDS, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Bethesda, Maryland* 20014

Parasites of mollusks are studied to determine: their identity, molluscan host range, mode of transmission, localization and pathology of infection, relation to schistosome infections, and potential use for biological control.

Selection and crossing experiments are conducted to find additional genetic markers in 'Biomphalaria glabrata', to increase knowledge of molluscan susceptibility to infection and to molluscicides.

Abnormal tissue growths observed in the course of the above investigations are studied to determine their cause; genetic, infection, or other.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

2.0277, BIOLOGY AND BIOLOGICAL CONTROL OF SCHISTOSOMIASIS

E. CHERNIN, Harvard University, School of Public Health, *Boston, Massachusetts* 02115

In an effort to resolve the controversial issue that snails produce an 'attractant' influencing the behavior of miracidia, a test system was devised to study reactions of Schistosoma mansoni miracidia to water- soluble substances emanating from Biomphalaria glabrata. Substances from these and unrelated snails altered miracidial behavior dramatically; non-molluscan aquatic invertebrates do not seem to produce the stimulant. The behavior of stimulated miracidia resembles that seen near snails and suggests a chemo-kinesis rather than a chemotaxis. Efforts are underway to identify the stimulant. In other studies, the crystalline styles of two species of Oncomelania were analyzed by polyacrylic gel electrophoresis; the styles differ in various ways but are most easily distinguished by differences in alkaline phosphatase isoenzymes. Finally, an unusual parasite, Aspidogaster conchicola has been found in two local species of Viviparus; the natural infections and their pathology have been described together with observations on the morphology and in vitro maintenance of the parasite.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

2.0278, SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY

E.G. BERRY, Univ. of Michigan, Museum of Zoology, *Ann Arbor, Michigan* 48104

Description: The aim of this project is to investigate and determine (a) the species of cercariae which cause swimmer's itch in lakes and streams occurring within a radius of 200 miles from Ann Arbor, Michigan: (b) to collect and identify the freshwater snails from the above radius and determine their natural rates of susceptibility for swimmer itch infections; (c) to investigate species of birds and/or small mammals which serve as definitive hosts for these parasites; (d) to investigate the seasonal distribution of the cercariae when swimmer's itch becomes a local problem in each of the several lakes within the above radius; (e) to establish in the laboratory the snails which serve as intermediate hosts and to infect the young from these specimens with miracidia to produce the swimmer's itch cercariae; (f) with cercariae liberated from the above snails infect laboratory experimental definitive hosts (e.g., canaries, mice or hamsters; (g) gather data which will be pertinent for control of snail hosts, e.g., bionomics of the snail, optimum age the snail becomes infected, number of miracidia required for high rates of infection, ecological habitats for each of the species of snails which serve as intermediate hosts, etc.; (h) length of time required for infection to develop in snails at various temperatures; (i) average numbers of cercariae shed by different species of snails, (j) time of day the cercariae are released from the snail; (k) the minimum number of hours at various temperatures when the cercariae cease to provoke swimmer's itch. All of these factors are pertinent prior to attempting control programs for this irritating environmental problem.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

2.0279, SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY

E.G. BERRY, Univ. of Michigan, School of Arts, *Ann Arbor Michigan* 48104

The aim of this project is to investigate and determine (a) the species of cercariae which cause swimmer's itch in lakes and streams occurring within a radius of 200 miles from Ann Arbor, Michigan; (b) to collect and identify the freshwater snails from the above radius and determine their natural rates of susceptibility for swimmer itch infections; c) to investigate species of birds and or small mammals which serve as definitive hosts for these parasites; d) to investigate the seasonal distribution of the cercariae when swimmer's itch becomes a local problem in each of the several lakes within the above radius; e) to establish in the laboratory the snails which serve as intermediate hosts and to infect the young from these specimens with miracidia to produce the swimmer's itch cercariae; f) with cercariae liberated from the above snails infect laboratory experimental definitive hosts (e.g. canaries, mice or hamsters); g) gather data which will be pertinent for control of snail hosts, e.g. bionomics of the snail, optimum age the snail becomes infected, number of miracidia required for high rates of infection, ecological habitats for each of the species of snails which serve as intermediate hosts, etc; h) length of time required for infection to develop in snails at various temperatures; i) average numbers of cercariae shed by different species of snails; j) time of day the cercaries are released from the snail k) the minimum number of hours at various temperatures when the cercariae cease to provoke swimmer's itch. All of these factors are pertinent prior to attempting control programs for this irritating environmental problem.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

2.0280, INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST

R.W. ALLEN, U.S. Dept. of Agriculture, Parasite Research Laboratory, *Las Cruces, New Mexico* (ADPB3-27)

OBJECTIVE: Define areas where Fasciola occurs; determine incidence in cattle, sheep, and reservior hosts; identify snail vectors and test control methods, and look for drugs effective in removing all stages from sheep and cattle.

APPROACH: Sample sheep and cattle in suspect areas to define boundaries and determine incidence and intensities of liver fluke infection. Collect snails from contaminated pastures for direct examination and for rearing and experimental infections in the laboratory. After identification of snail vectors, to investigate means of snail control by chemical or biological means. Treat naturally and experimentally infected sheep with promising drugs in an effort to remove all developmental stages of flukes from ruminant livers.

PROGRESS: The number of counties known to be enzootic for Fasciola hepatica as determined by our studies includes one in Colorado, one in Arizona, and six in New Mexico. Approximately 35 percent of the cattle and sheep sampled in habitats suitable for snails were infected. The snails so far incriminated in the transmission of fascioliasis are Fossaria modicella, Stagnicola palustris, and S. bulimoides. Rouen ducks reduced the natural population of potential snail vectors by 93 percent in controlled tests within an endemic area in eastern Arizona. Six 9-week old ducks were confined within four 100 square foot areas for 23 hours each and the snail population estimated before and after introduction of the ducks. The percent reduction of lymnaeid snails within the 4 plots ranged from 90 to 95 percent. Preliminary work involving lamb feeding trials indicated that metacercariae of F. hepatica are destroyed in passage through the digestive tract of the ducks. This provides an added advantage in controlling fascioliasis. Preliminary tests indicate that extracts from broom snakeweed, Gutierrezia sarothrae, caused from 50 to 100 percent mortality in cultures of S. palustris, when the plant material was allowed to soak in the water of the cultures from 1 to 24 hours. Broom snakeweed, one of the common range plants in the Southwest, is toxic when eaten by livestock. The toxic material is saponin, which probably is the agent active against snails. The minimum level necessary to control snails will be determined.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - V.S.R

2.0281, BIOLOGY AND CONTROL OF TERRESTRIAL MOLLUSCS

F.D. JUDGE, New York State Agric. Sta., *Geneva, New York* 14456 (NYG00560)

OBJECTIVE: Develop effective programs for the control of terrestrial molluscs. Investigate pertinent aspects of life-cycle and behaviour.

APPROACH: Laboratory cultures of certain terrestrial molluscs will be initiated. Initially the gray garden slug Deroceras reticulatum Muller will be used. From these cultures aspects of life-cycle will be studied such as time taken to hatch, time to reach reproductive maturity, number of fertile eggs produced, etc., at various temperatures. In addition, the amount of food consumed and the activity of molluscs at different light/humidity/temperature regimes will be studied. Screening programs for the evaluation of materials as candidate molluscicides will be carried out initially in the laboratory and greenhouse and the best materials from these programs will be evaluated in the field.

SUPPORTED BY New York State Government - Albany

2.0282, BIOLOGICAL STUDIES OF MALACOPHAGOUS DIPTERA

C.O. BERG, Cornell University, Graduate School, *Ithaca, New York* 14850

Biological studies of malacophagous Diptera (Sciomyzidae) have identified some especially intriguing and potentially rewarding avenues of further research and laid the groundwork for concentrated effort on them. Progress made earlier includes studies of the natural history and ecological relationships of 180 species of Sciomyzidae. The larvae of all reared species are predatory or parasitoid killers of aquatic snails, land snails, slugs, and fingernail clams. Three unrelated investigations suggested and made possible by past research are now proposed, two in environmental and one in physiological biology. The first of these will focus on the toxic principle produced in the salivary glands of these fly larvae and its physiological effects on slugs. Secondly, population regulation in snails through predation by sciomyzid larvae will be examined. Finally, an intensive study of the biology, ecology, morphology of the immature stages, and phylogenetic relationships of all species of the genus Dictya.

SUPPORTED BY U.S. National Science Foundation

2.0283, EUROPEAN SCIOMYZIDAE

C.O. BERG, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00644)

OBJECTIVE: Find particularly efficient species of snail-killing flies, acquire the necessary knowledge of their biology, and introduce them for biological control into regions having serious snail or slug problems.

APPROACH: We are rearing and studying all possible species of snail or slug-killing flies from all parts of the world to determine: the mean number of mollusks killed by an individual in each species of fly, the fecundity and average generation time in each species, any selectivity for species, size, or habitat of snail displayed by fly larvae, natural resistance or escape methods, especially in the dangerous and destructive species of mollusks, searching methods and mean searching time of fly larvae under various conditions, and other biological attributes of both the snails and the flies that must be understood before we can hope realistically to control any snail pest by introducing a snail-killing fly.

PROGRESS: The major tangible accomplishment during 1969 was publication of the 3 large papers listed below. In addition, a paper on biology and immature stages of Salticella fasciata, a European sciomyzid fly having very interesting larval habits, was completed and submitted to (and accepted by) the Royal Entomological Society. A taxonomic revision of the South American genus Tetanoceroides is almost finished and ready for publication. Much progress has been made on 3 doctoral dissertations on different aspects of this research problem by Jay Abercrombie, Karl Valley, and Jan Zuska. Finally, preliminary negotiations have taken place between the principal investigator and 2 scientists in Latin America who are vitally concerned with snail problems and anxious to investigate the possibilities of biological control with sciomyzid flies.

SUPPORTED BY New York State Government - Albany

2.0284, 'A METHOD OF DESTROYING ONCOMELANIA-THE SNAIL VECTOR OF SCHISTOSOMIASIS'

N.F. CARDARELLI, Univ. of Akron, Undergraduate School, *Akron, Ohio* 44304

It has been discovered that a known molluscicide combined with an attractant and properly formulated will rapidly and effectively destroy marine snails. It is believed that the same or similar materials spread as a bait granule will be effective against Oncomelania. The pellet will be easy to handle and measure, relatively non-toxic to humans and higher animals, long-lasting, stable, and 100% effective in destroying Oncomelania and perhaps other amphibious snails of economic importance.

The major attractants vary from Sodium alginate to wheat paste, fish flour & casein. The different attractants and molluscicides are being tested in Oncomelania formosana.

SUPPORTED BY U.S. Dept. of Defense - Army

2.0285, METHOD OF KILLING ONCOMELANIA & AQUATIC SNAIL VECTORS OF SCHISTOSOMIASIS

N.F. CARDARELLI, Univ. of Akron, Graduate School, *Akron, Ohio* 44304

Molluscicides such as organotins, organoleads, & Bay-73 are incorporated into acrylic compounds containing a snail attractant. The snail moves to and ingests the pellet, mortality occuring within minutes. Pellets are water insoluable thus not polluting the immediate environment. Attractant are species specific. Similar preparations are prepared and evaluated against amphibious snails. The goal is to find a more effective weapon against Schistosomiasis vectors, in terms of extended life, greater economy, better dispersion, and easier handling.

Specific toxicants used are Bay-73, bis(tri-n-butyl-tin) oxide, tributyltin acetate, tributyltin resinate, triphenyllead laurate, & tripenyl lead acetate. Attractants vary from Beef heart infusion agar to powdered lettuce. Snail genera used are fluke infected Helisoma trivolvis, and non-infected Vivaparus, H. planorbis, Polygyra, Oncomelania, Emarginata, & Stagnicola. Binders are of the hydrophillic acrylics crosslinked for use in alkaline waters, of the 'Carboset' (trademark) family.

SUPPORTED BY Ford Foundation - New York, N.Y.

2.0286, DEVELOPMENT OF A TOXIC BAIT

N.F. CARDARELLI, Univ. of Akron, Graduate School, *Akron, Ohio* 44304 (NIH-70-2273)

Independently and not as an agent of the Government, the Contractor shall exert its best efforts to: 1. Conduct experiments in an effort to develop an optimal economic bait formulation that would be practical and effective for use against 'Biomphalaria glabrata' and other vectors of schistosomiasis. 2. Study several compound variations which include the toxicant, attractant, binder, in the formulation of a pellet. Evaluation will be performed initially at the Creative Biological Laboratory in Akron, Ohio. Candidate formulations will be evaluated as to their effectiveness with infected and non-infected snails and various non-infected schistosomiasis vectors recommended by the Project Officer.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

2.0287, STUDY THE BIOLOGY OF A GROUP OF SNAIL-KILLING FLIES

B.A. FOOTE, Kent State University, School of Arts, *Kent, Ohio* 44240

To study the biology of a group of snail-killing flies; this may help in developing a biological agent rather than a polluting chemical poison that will destroy snail hosts that transmit the flukes that cause the dread disease, Schistosomaisis. Special Techniques: collecting trips; field observations; and certain laboratory rearings will be conducted. Representative material of the eggs, three larval instars, and puparia will be preserved. The preserved material subsequently will serve as the basis for detailed studies of the morphology of the immature stages and will permit, valid comparisons between and within genera. A comparative study of the larval feeding habits will be made so that a deeper insight into the phenomenon of adaptive radiation within the family can be obtained. This study may allow for the recognition of previously unsuspected evolutionary trends.

SUPPORTED BY Natl. Geographic Soc. - Washington, D.C.

2.0288, ENTOMOLOGICAL PESTS OF VEGETABLE CROPS

H.H. CROWELL, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00086)

OBJECTIVE: Study the biology and habits of insects and certain other invertebrate animals associated with vetegable crops. Develop control measures for entomological pests of vegetable crops. Study the side effects of control measures as regards other entomological fauna associated with vegetable crops, on the growth and quality of the crops, and on the possible existence of toxic residues remaining on produce at harvest time.

APPROACH: Studies made on the biology, habits, and natural enemies of entomological pests of vegetable crops. Adaptation of cultural controls and horticultural practices for crop protection investigated. Testing of insecticidal chemicals conducted. Study complications arising from use of control measures, such as changes in produce flavors, presence of toxic residues, and effects on other fauna and flora associated with vegetable production.

PROGRESS: Cabbage maggot: Dipping of bare rooted transplants of 4 major cole crops in emulsions of diazinon, BAY 37289 or BAY 77488 did not produce detectable phytotoxic effects. Maggot control with BAY 37289 was excellent on all 4 varieties after 35 days. Diazinon and BAY 77488 gave moderate protection on broccoli and brussel sprouts; slight protection to cabbage; and showed no differences from the untreated check on cauliflower. All 3 treatments gave excellent protection against a heavy symphylan infestation in the experimental plots. The compatibility of zinophos and trifluralin was tested on 7 major, direct seeded, cruciferous crops. Combining these 2 materials in a broadcast soil treatment produced no detectable incompatibilities. Pea weevil: Willamette Valley garden pea plantings showed that diazinon and dimethoate sprays, although effective against pea aphids, were not satisfactory for weevil control. DDT residues in shelled peas sprayed 7 days before harvest were below the 1 ppm tolerance. Slugs & Snails: Laboratory and field tests were run with 2 carbamates (BAY 37344 and UC 30045) and metaldehyde bait formulations. Over 80% recovery by slugs from metaldehyde poisoning under moist field conditions demonstrated. Addition of metaldehyde to carbamate baits did not increase their effectiveness. Laboratory studies on 2 molluscan predators (Gonaxis & Euglandina) show promise for control of brown garden snail.

SUPPORTED BY Oregon State Government - Salem

2.0289, BIOLOGY AND CONTROL OF TERRESTIAL MOLLUSKS

H.H. CROWELL, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00900)

OBJECTIVE: To study the biology and habits of native and introduced terrestial mollusks of Oregon. To conduct laboratory screening tests in a search for new and better materials for the chemical control of slugs and snails of economic importance. To investigate non-chemical methods (predators, parasites, diseases, etc.) for control of economic populations of injurious slugs and snails. To make periodic surveys for the detection of introductions or establishments of terrestial mollusks new to Oregon.

APPROACH: Slug and snail species known to be injurious to Oregon row crops, forage crops or home gardens will be laboratory reared for biological studies and for chemical screening trials. Promising chemicals will be field tested in comparison with the standard (but unsatisfactory) metaldehyde baits. Biological control agents such as predator snails will be studied in the laboratory and possibly increased in numbers for future releases in selected coastal or Willamette Valley locations.

PROGRESS: Laboratory screening tests involved over 35 experimental pesticides against 4 species of mollusl, and as contact broadcast applications as well as in bait formulations. The standard for comparison in all tests was the carbamate, BAY 37344, which is currently being developed as a bait for commercial sale by a private chemical company. Materials which have shown higher activity, often at lower concentration, than BAY 37344 are the carbamates SD-17250 and SD-16898; the organotins TD-5032 and TD-1612; and a benzimidazol, Lovozal (NC- 5016). The last 2 types of chemical are somewhat repellent to the mollusks when presented in bait form. Only the carbamates of the highly toxic materials show molluscicidal activity by contact from granules or wettable powders broadcast on moist soil. Biological studies on the predacous snails, Euglandina and Gonaxis, have been hindered by the inability to increase their populations under laboratory conditions.

SUPPORTED BY Oregon State Government - Salem

2.0290, CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER

H.W. BOND, Univ. of Rhode Island, School of Pharmacy, *Kingston, Rhode Island* 02881

A series of vinyl sulfones will be synthesized and screened for potential molluscicidal activity against Australorbis glabratus, an intermediate host for human schistosomiasis. The mechanism of action of active compounds in this series will be investigated through the use of in vitro systems prepared from snail tissue. Structure activity correlations will be determined through the use of in vivo and in vitro systems. 'No effect levels' of potentially useful molluscicides in terrestrial animals will be determined.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

2.0291, MOLLUSCICIDES - A CORRELATION OF STRUCTURE VS. ACTIVITY

B.H. PRINGLE, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Environ. Health Service, *Narragansett, Rhode Island* 02882

Up through June 1, 1970, approximately seventy-five alpha or beta- nitrostyrenes and related compounds have been studied following their synthesis and purification. Their molluscicidal activity against 'Australorbis glabrutus', vector of 'Schistosoma mansoni' has been determined; eight alpha nitrostilbenes and related compounds have been similarly studied. Those compounds in each series bearing the nitroolefinic grouping, -C equals C-NO(2), are highly molluscicidal, while those compounds lacking this particular grouping are essentially devoid of activity. The most molluscicidal of the forty-three compounds tested in beta-nitrostyrene itself.

The activity of these nitroolefins is undoubtedly due to their ability to inhibit sulfhydryl-dependent respiratory enzymes in the snail.

Suggestions have been garnered from these studies as to other types of chemical compounds known to be sulfhydryl inhibitors that should be studied for their molluscicidal activity.

As a part of the study of structure versus activity of beta-nitrostyrenes, some 4-(substituted phenoxy)-3, beta-nitrostyrenes were prepared and tested for their toxicity to 'A. glabratus'. It was thought that inclusion of the highly molluscicidal phenolic moiety might possibly impart increased activity to the beta-nitrostyrene molecule. Such was the the case; all six of the new compounds synthesized were found to be less active against 'A. glabratus than is beta-nitrostyrene itself.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - E.H.S.

2.0292, EFFECTS OF A SNAPPING TURTLE POPULATION ON THE WATERFOWL PRODUCTIVITY OF A MARSH

D.A. HAMMER, Utah State University, State Coop. Wildlife Res. Unit, *Logan, Utah* 84321

The snapping turtle (Chelydra serpentina) has an important role in marsh ecology throughout most of North America. However, its relationships with other marsh inhabitants have been inadequately studied. Considerable life history data were obtained in a previous study (Hammer, 1969). This study is designed to define waterfowl - nest predator - snapping turtle interrelationships and to recommend appropriate management procedures. These interrelationships are being systematically studied on five waterfowl management units at the Lacreek National Waterfowl Refuge near Martin, South Dakota.

Numerous observations and reports indicate that some waterfowl predation by snapping turtles occurs. Consequently, snapping turtle control programs have been established on many refuges or waterfowl production areas. In turn, however, snapping turtle nests are preyed upon by mammalian predators. Turtle-nesting areas often are restricted and highly vulnerable to detection by mink (Mustela vison), skunks (Mephitis mephitis and Spilogale putorius), and raccoons (Procyon lotor). Early attempts to correlate snapping turtle nest predation with waterfowl nest predation indicated that snapping turtle nests may act as a buffer during the waterfowl nesting season.

OBJECTIVES: 1. To determine the importance of snapping turtle predation upon waterfowl on the Lacreek Refuge. 2. To determine the importance of snapping turtle nests as a buffer to predation on waterfowl nests. 3. To evaluate the influence of snapping turtles upon waterfowl productivity on the Lacreek Refuge. 4. To recommend turtle population management procedures.

Work began in 1968. Termination is planned for 1971 fiscal year.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

2.0293, OYSTER DRIL (OCINEBRA JAPONICA) CONTROL

R.E. WESTLEY, State Dept. of Fisheries, *Olympia, Washington* 98501

Part I Behavioral Studies: Laboratory studies will continue on behavior and reproduction habits of Japanese oyster drills. These studies are aimed at determining any particular behavioral patterns that would make drills susceptible to trapping, or otherwise provide opportunities for destroying or controlling these populations. Such behavioral studies will include congregation for copulation, sex ratios, attraction to particular food types, and habits of newly hatched drills.

Part II Chemical Control of Oyster Drills: Laboratory studies will continue on families of chemical compounds screened for their promise of destroying Japanese oyster drills at some particular state of their life history when it would be feasible to apply chemical control measures.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

2.0294, THE CONTROL OF SLUGS

L.W. GETZIN, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01686)

OBJECTIVE: Surveys of slug species and their natural control agents. Develop adequate control measures for slugs through chemical and cultural practices.

APPROACH: Quantitative counts in fields, home gardens, lawns, correlate slug populations with enviornmental factors, cultural practices, soil conditions and other factors involved in population dynamics. Control: screening of molluscicides. Chemicals with high oral toxicity are incorporated in bait formulations and tested for slug control.

PROGRESS: An experimental carbamate compound, presently designated as SD-17250, was very effective against the grey garden slug and the reticulated slug in preliminary trials. In bait formulations it killed greater numbers of slugs than the standard metaldehyde treatment. Comparative studies with baits and sprays of promising molluscicides on field corn revealed that effective slug control can be obtained with baits and sprays of Mesurol, a carbamate insecticide that is being developed for commercial usage in the United States. Life history studies on 4 important slug species of western Washington are nearing completion. Eggs vary from 2 to 6 mm in diameter depending upon the species. Oviposition is limited to certain times of the year for some species while others lay eggs any time that satisfactory temperature and moisture conditions exist. Most species have a one year life cycle although the larger species are capable of living for longer periods. These studies are aimed at uncovering biological weaknesses within the various species that may aid in their control.

SUPPORTED BY Washington State Government - Olympia

2.0295, EFFECT OF PRETREATMENT MOLDING OF SOUTHERN PINE ON THE PERMANENCE OF THE PRESERVATIVE IN SEAWATER EXPOSURE

L.R. GJOVIK, U.S. Dept. of Agriculture, Forest Products Laboratory, *Madison, Wisconsin* 53705

Determine the effect that pretreatment molding may have on the permanence of multisalts and creosote preservative in treated pine exposed to seawater. Determine the effect of pretreatment molding on the service life wood in navy waterfront structures exposed to limnoiria attack. Improve wood marine piling and reduce maintenance costs of navy waterfront facilities.

Short sections of small, round southern pine will be exposed at the Naval Station, Key West, Florida. Some specimens will be kiln dried and the other mold infected then kiln dried. Each group will have posts treated with CCA, creosote, and combinations of these. These will be investigated to determine losses of or changes in preservative that occur progressively in uninfected wood versus those occurring in the more permeable molded wood and correlate observed preservative changes and the incident of marine-borer attack. Scheduled analysis after 10 years exposure is subject to change pending the outcome of chemical analysis at 1, 2, 3, and 5 years.

Test specimens were installed in December 1968.

SUPPORTED BY U.S. Dept. of Defense - Navy

2.0296, MARINE PILING ANALYSIS

T.C. SCHEFFER, U.S. Dept. of Agriculture, Forest Products Laboratory, *Madison, Wisconsin* 53705

Investigate improved means for inspecting for quality of wood piling preservative treatment to determine its suitability for marine use in navy waterfront structures.

The work includes investigation of X-ray fluorescence spectrography for analyzing penta and waterborne salts, exploratory work on the use of atomic absorption spectrophotometry for waterborne salts, investigation of thin layer chromotography for detecting petroleum adulteration, and other techniques for improved assay.

Adaptation of the X-ray procedures to the analysis of waterborne salts still presents a problem due to the interference of the metallic elements upon one another. Work included the use of an atomic absorption spectrophometer for analysis of waterborne salts. Initial work on the thin layer chromatography for detecting petroleum adulteration in creosote was completed. Additional work is continuing to evaluate the effectiveness on used creosote which contains wood resins and extractives.

SUPPORTED BY U.S. Dept. of Defense - Navy

DESCRIPTION OF RESEARCH TASKS

FISH AND SHELLFISH PATHOLOGY

3A. EPIDEMIOLOGY

(No Control or Treatment Evaluated or Suggested)

3.0001, EPIZOOTIOLOGY OF PARASITIC DISEASES IN FISH POPULATIONS UNDER INTENSIVE MANAGEMENT
R. ALLISON, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00294)

OBJECTIVE: Develop a serological technique for detecting infections of protozoan and micro-helminth parasites in fish populations. Develop techniques for immunizing fish to infections with Ichthyophthirius, Scyphidia, Trichophrya and other parasites which produce epizootics in managed pond populations. Experiment with various management practices and determine their relationship to parasitic epizootics.

APPROACH: Samples of wild fish will be collected from unmanaged populations. The incidence of parasitic infections will be evaluated by serological, electrophoretic and challenge methods. Populations of parasitic species associated with epizootics will be propagated on parasite-free fish. Experiments using various serological techniques for identifying specific parasitic infections in controlled host populations will be conducted. Production methods will be experimented with and related to epizootic parasitism. Various methods will be attempted for immunizing fish populations to control epizootic parasitism.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

3.0002, IDENTIFICATION OF PARASITIC BACTERIAL FORMS
J.A. PLUMB, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830

Objectives: 1. Identify and test pathogenicity of bacteria isolated from fish involved in fish kills within the Cooperating States.

Procedures: 1. With the use of standard microbiological identification techniques, isolate and identify the bacterial forms found on fish specimens from fish epizootics and test the pathogenicity of the isolated bacterial forms.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0003, INVESTIGATE CONTROL MEASURES OF BACTERIAL INFECTIONS IN FISH
J.A. PLUMB, Auburn University, Graduate School, *Auburn, Alabama* 36830

Objectives: 1. To investigate feasible control measures for bacterial infections in fish.

Procedures: 1. Set up experiment in aquaria using either artificially or naturally infected fish and evaluate the efficacy of various chemotherapeutics and drugs on these infections.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0004, DETECTION OF CHANNEL CATFISH VIRUS (CCV) IN BROODSTOCK
J.A. PLUMB, Auburn University, Graduate School, *Auburn, Alabama* 36830

Objectives: Establish reliable techniques for detecting CCV in channel catfish populations.

Procedures: Utilization of various sampling techniques in an attempt to isolate CCV from artifically infected adult channel catfish.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0005, METHOD OF CONTROLLING MORTALITY IN CHANNEL CATFISH DUE TO CCV INFECTION
J.A. PLUMB, Auburn University, Graduate School, *Auburn, Alabama* 36830

Objectives: Investigate methods of controlling mortality due to CCV infection.

Procedure: Inoculate susceptible channel catfish fingerlings with CCV and incubate at optimum water temperature. When mortality begins, alter temperature to evaluate what effect this has on the total mortality.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0006, EVALUATION OF THE INFLUENCE OF AGE AND SIZE OF CHANNEL CATFISH ON THE INFECTIVITY OF CCV
J.A. PLUMB, Auburn University, Graduate School, *Auburn, Alabama* 36830

Objectives: 1. To determine the ages and sizes of channel catfish that can be artificially infected with CCV.

Procedures: 1. From a common lot of fish, attempt to infect samples at monthly intervals from feeding fry stage to a minimum age of 18 months. 2. Methods of inoculation will include interperitoneal injection and feeding the virus.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0007, SUSCEPTIBILITY OF OTHER SPECIES OF CATFISHES TO CCV AND THEIR POSSIBLE ROLE AS CARRIERS
J.A. PLUMB, Auburn University, Graduate School, *Auburn, Alabama* 36830

Objectives: 1. To determine species of catfishes susceptible to CCV, including white catfish, blue catfish, flathead catfish, brown, yellow and black bullheads, and hybrids.

Procedures: 1. Using three routes of inoculations, infect fingerling white, blue and flathead catfish; brown, black, and yellow bullheads with CCV. 2. Attempt to reisolate the virus from the mortalities and to determine if those surviving are carriers.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0008, DEVELOPMENT OF NEW FISH CELL LINES
J.A. PLUMB, Auburn University, Graduate School, *Auburn, Alabama* 36830

Objectives: 1. To develop new fish tissue cell lines to aid in detection of fish virus diseases and facilitate fish virus research.

Procedures: 1. Remove suitable tissue from several species of fish and by using established techniques cultivate these tissues and cells in-vitro.

FISH AND SHELLFISH PATHOLOGY

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0009, COOPERATIVE FISH DISEASE PROJECT

J.A. PLUMB, Auburn University, Graduate School, *Auburn, Alabama* 36830

Objectives: 1. To identify a virus disease of rainbow trout which were imported from the Pacific Northwest.

Procedures: 1. By using RTG-2 cell cultures and routine techniques determine the size and sensitivity of the virus to pH, temperature, ether and glycerine.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0010, CHANNEL CATFISH VIRUS REPLICATION CURVES IN INTERNAL ORGANS AND ASSOCIATED PATHOLOGY

J.A. PLUMB, Auburn University, Graduate School, *Auburn, Alabama* 36830

Objectives: 1. To establish virus replication curves of CCV in internal organs: 2. Establish time sequence pathological changes in internal organs of infected fish.

Procedures: 1. Inoculate channel catfish fingerling with CCV and at 24 intervals sample these fish and determine the level of virus infections doses per ml of organ. 2. Sample fish at 24 hr. intervals and prepare the pattern of pathological development in the organs.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0011, DISTRIBUTION OF THE GENUS ERGASILUS (PARASITIC COPEPOD) IN THE SOUTHEASTERN UNITED STATES

W.A. ROGERS, Auburn University, School of Agriculture, *Auburn, Alabama* 36830

Objectives: 1. To provide a better understanding of the distribution, host-parasite relationships, and extent of infestation of the genus Ergasilus.

Procedures: 1. Gills of fish from fresh and brackish waters collected from the field and from Ichthyological museums will be examined. 2. Fish species from several Gulf drainages will be intensively examined while species from other areas will be examined at random.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0012, COOPERATIVE FISH DISEASE PROJECT

W.A. ROGERS, Auburn University, School of Agriculture, *Auburn, Alabama* 36830

Objectives: 1. Methods for rearing of Ergasilus will be attempted and evaluated. 2. Attempts will be made to determine time of infection, longevity, time of fertilization, numerical relationships and overwintered conditions. Such knowledge would be valuable for future control work.

Procedures: 1. Wild infected fish will be collected and held in ponds until needed. 2. Rearing methods will be attempted in the lab in aquaria and troughs with flowing water. Follow-up rearing attempts will be made in ponds in the field.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0013, PATHOLOGY OF AEROMONAS LIQUIFACIENS IN CHANNEL CATFISH

W.A. ROGERS, Auburn University, School of Agriculture, *Auburn, Alabama* 36830

Objectives: 1. Plot course of A. liquifaciens infection against time. 2. Follow route of A. liquifaciens in body of fish. 3. Observe effect of environment on virulence of A. liquifaciens. 4. Obserrve effect of various handling techniques of susceptibility of fish.

Procedures: 1. Infected fish will be autopsied over a period of time to determine route of infection. 2. Various common environmental stresses (temperature. pH, hardness) will be used to observe their effect on the infectivity of A. liquifaciens. 3. A variety of handling methods wll be used to determine their effect on the susceptibility of fish to A. liquifaciens.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0014, INVESTIGATIONS OF AMEBIASIS IN FISH

W.A. ROGERS, Auburn University, School of Agriculture, *Auburn, Alabama* 36830

Objectives: To identify and determine the pathology of an amoeba found in the blue tilapia and channel catfish.

Procedures: 1. An attempt will be made to culture and identify an unknown amoeba found in tissues of fish: 2. Tissues will be sectioned and pathology determined if possible.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0015, COOPERATIVE FISH PARASITE AND DISEASE STUDY

W.A. ROGERS, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA-13-0421)

OBJECTIVE: Determine the disease producing organisms responsible for epizootics in fish populations in each of the seven cooperating states. Conduct research on identification, life history, epizootiology, pathogenicity and control of organisms associated with fish kills.

APPROACH: Sites of fish kills will be visited by project personnel to collect dead and dying fish. Fish collected by State biologists will be shipped to Auburn. Collected fish will be examined using standard parasitological and microbiological techniques. Isolated pathogens will be utilized to produce diseases in laboratory fish for research.

PROGRESS: One hundred seven cases were received for diagnosis at the Southeastern Cooperative Fish Parasite and Disease Laboratory. A breakdown of cases is as follows: parasites 34, bacteria 25, viruses 3, routine examinations 14, water quality or pollution 9, miscellaneous (including gas bubble disease, nutritional disease, etc.) 7, and undetermined 15. Fish Disease short courses have been presented in four of the cooperating states and plans made to present courses in the remaining three. Research on the channel catfish virus disease has centered on detecting carrier broodstock, evaluating temperature as a means of control, bioassaying internal organs, and obtaining additional information on size susceptibility of fish. Three new fish cell lines were established in tissue culture to facilitate virus research. In an attempt to associate gill monogenean parasites with speciation and phylogeny of hosts, 874 collections of gills from museum fish have been made and are being analyzed. Gill collections from approximately 6,000 fish from 3,000 localities have been made on a parasitic copepod study.

SUPPORTED BY Alabama State Government

3.0016, PUBLICATION OF FISH BACTERIAL RESEARCH

UNKNOWN, Auburn University, Graduate School, *Auburn, Alabama* 36830

Objectives: Publish results of fish bacterial research.

Procedures: Results of research will be published in technical Journals, Bulletins, etc.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0017, PUBLICATION OF FISH VIRUS RESEARCH

UNKNOWN, Auburn University, Graduate School, *Auburn, Alabama* 36830

Objective: Publish results of fish viral research.

Procedure: Results of research will be published in technical Journals, Bulletins, etc.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0018, IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES

D.A. BECKER, Univ. of Arkansas, Water Resources Research Ctr., *Fayetteville, Arkansas* 72701

The proposed study is the first pre-impoundment through early impoundment investigation of this nature to be conducted in the United States.

Field investigations will employ electrical shocking gear for the live collections of the black basses Micropterus dolomieui (Lacepede), M. punctulatus (Rafinesque), and M. salmonides (Lacepede).

Basses will be examined in the laboratory for helminth and copepod parasites in an effort to follow the quantitative and qualitative dispersions and fluctuations of these parasites as the water quality is effected by the water level fluctuations from a river to a reservoir environment. Standard and total length, weight, and scale samples will be obtained to ascertain the effect of parasitism on the aging and growth rates of basses which may help explain why sport fishing declines after several years in recently impounded reservoirs effecting the recreational economy of the municipalities surrounding reservoirs. Parasitism will be related to the whole food chain in an attempt to establish another parameter for water quality.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

3.0019, LIMNOLOGICAL, ICHTHYOLOGICAL, AND PARASITOLOGICAL INVESTIGATIONS ON ARKANSAS RESERVOIRS IN RELATION TO WATER QUALITY

P.M. JOHNSTON, Univ. of Arkansas, Water Resources Research Ctr., *Fayetteville, Arkansas* 72701

The overall objective of this investigation is to evaluate the effects of impoundment and ageing and/or eutrophication of selected Arkansas impoundments on limnological, ichthyological and parasitological water qualities during the past 30 years.

The limnological investigation is to monitor physico-chemical and plankton parameters and to compare with those of the past 30 years. Qualitative and quantitative fluctuations of the plankters will be correlated with the abiotic factors to understand the seasonal cycles. Standardized methods will be employed in the determination of the physico-chemical factors.

The ichthyological study is to determine qualitative and quantitative aspects of the feeding biology of largemouth bass in relation to available food. Seasonal and annual growth rates, length- weight relationship, and condition factor will be studied in relation to abiotic and biotic factors. Standing crops of fish will be evaluated in relaton to physico-chemical factors and plankton.

The parasitological investigation is to study the qualitative and quantitative aspects of the helminth and crustacean parasites of selected game fishes. Effects of parasitism on the fish's condition factor and the overall interrelationships between these aspects and the abiotic and biotic factors will be evaluated to understand the decline in fishing success with the aging of reservoirs.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

3.0020, STUDY OF THE INCIDENCE AND LIFE CYCLES OF MYXOSPORIDIAL INFECTIONS IN WARM WATER FISHES (REVISED)

F.P. MEYER, U.S. Dept. of the Interior, Fish Farming Exptl. Sta., *Stuttgart, Arkansas* 72160

Myxosporidial infections of warmwater fishes are becoming increasingly evident. Attempts will be made throughout the year to identify trophozooite stages, different species of parasites, and seasonal incidence. Tissues from organs within infected hosts will be studied for developmental stages of the parasites and to assess damage resulting from myxosporidial infections. Efforts will be made to establish modes of infection and to transmit the parasites under laboratory conditions.

SUPPORTED BY U.S. Dept. of Interior - Bu Sport Fish.

3.0021, EPIDERMAL PAPILLOMAS

S.R. WELLINGS, Univ. of California, School of Medicine, *Davis, California* 95616

The purpose of this proposal is to determine the causative agents and biological significance of the commonly occurring and geographically widespread epidermal papillomas of flounders. The following will be determined: transplantability, transmissibility and possible viral etiology. In addition, tumor and normal tissue will be cultured in vitro, and the cells karyotyped in order to establish whether a previously observed bizarre hypertrophic cell found in the tumors is a transformed fish cell, or is an exogenous unicellular parasite. Further attempts will be made to induce skin tumors with X-ray and chemical carcinogens added to the water. The relation of the disease to obvious sources of pollution will be determined. The ecological factors correlation with tumorigenesis will be determined by intensive collections, and the distribution of the disease mapped in Puget Sound by species and location. Normal tissue, tumor, and fish protein concentrate (of the kind presently fed to humans) prepared from normal and tumor tissue, will be fed to fish and mice in order to observe any deleterious effects. In summary, at the termination of the project we hope to be able to define the neoplastic or hyperplastic nature of the disease, its transplantability and transmissibility, the possible significance of inclusion of tumor tissue in human and animal food, and the usefulness of the system as a model of human disease, or as an indicator of water pollution.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

3.0022, OYSTER DISEASE MORTALITY ALONG THE CALIFORNIA COAST

P.M. ROEDEL, State Dept. of Fish & Game, *Sacramento, California* 95819

Summary of Proposed Work: The objective is to relate environmental and pathological conditions of oysters to mortalities in California growing areas.

Monitoring will be continued in Humboldt Bay, Tomales Bay, and Drakes Estero, and discontinued in Morro Bay and Elkhorn Slough. Monitoring in Tomales Bay will be twice monthly during the period of highest mortality (May-October). Sampling will be three times per week. Dead and ailing oysters and plankton samples will be collected from the sampling stations and commercial beds at each visit, and live oysters from the sampling stations weekly. Comparative studies of the survival of Pacific Oyster seed will be undertaken in Humboldt Bay. Five groups of seed oysters will be monitored; two each from Washington and Japan, and one from British Columbia. An Assistant Marine Biologist will be assigned to Eureka to accomplish the increased work load.

Water quality monitoring will include continuous temperature recording in Humboldt Bay, Tomales Bay, and Drakes Estero, as well as temperature, salinity and pH of water samples collected at all sampling stations.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0023, EPIZOOTIOLOGY OF LEPTOSPIRES - FISH SUSCEPTIBILITY TO L. ICTEROHAEMORRHIGICA (ABBREV)

J.G. COUSINEAU, Laval University, *Quebec City, Quebec, Canada*

Epizootiology of leptospires. Susceptibility of fish to L. icterohaemorrhigica and factors which influence the survival and virulence of leptospires in an aqueous medium.

SUPPORTED BY Canadian Government - Ottawa

3.0024, SURVEY OF ANIMAL DISEASES IN CONNECTICUT

C.F. HELMBOLDT, Univ. of Connecticut, Agricultural Experiment Sta., *Storrs, Connecticut* 06268 (CONS00118)

OBJECTIVE: Determine the occurrence of various animal diseases in Connecticut. Laboratory diagnostic facilities are provided. The relative economic importance of various diseases is being determined. The project serves as a source of leads on diseases needing extensive investigation in the State.

APPROACH: Mammals and birds are submitted to the Department of Animal Diseases for necropsy by agricultural interests and veterinarians. Staff veterinarians of the Department do the necropsy and may save time for histopathology, bacteriology, virology, biochemistry, and serology. All cases are reported to

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the Commissioner of Agriculture and Natural Resources, and the clinical signs and our work-ups are filed here. This adds to the file which is continuous since 1930. If tissues are studied, slides and blocks are also saved. This approach results in an unusual museum of histopathologic material. In recent years gross color transparencies have been made of interesting cases adding to the significance of the file.

PROGRESS: Avian Diseases - In this area Marek's disease and coccidiosis still account for most of the 5,372 accessions. Necrotic enteritis, etiology unknown, has suddenly appeared in 6-week-old birds on at least three occasions. It now does not appear to be a major threat. Fish Diseases - This is a new area, and since every group or species of fish examined has diseases, statistics mean nothing at this time. A striped bass (Morone saxitalis) was found to have an embryonal nephroma, a tumor never reported in this species. Of greater significance was the discovery of epitheliocystis in fish in brackish water. Electron microscopy studies revealed the cause as a Bedsonia sp. 250 fish were necropsied. Mammalian Diseases - Infectious diseases in pet species seem to be less important than ever. Neoplastic diseases are the dominant forms, probably the result of 'cancer conscious' clinicians. Space does not allow discussion here, but it should be noted that these tumors are classified in a number of ways, and the data is useful in preparing papers. The farm animals consist largely of cattle and horses. In the latter, colitis x has appeared at least three times, and efforts to transmit it were unsuccessful. Parasitism by Strongylus vulgaris is a serious problem and causes unthrifty animals as well as death.

SUPPORTED BY Connecticut State Government - Hartford

3.0025, DISEASES OF FISH

W.R. WHITWORTH, Univ. of Connecticut, School of Agriculture, *Storrs, Connecticut* 06268

A survey was made of the number of types of diseases and parasites present in fish in the Quinnebaug and Thames rivers between Danielson and New London to evaluate the potential hazards to any non-native fish that might be introduced into these rivers. Initial results indicate that diseases and parasites have minimal effect on the fish in this area, except when environmental conditions are very poor, for example when flow is low and pollutants increase. The numerous slides of normal and disease tissue that were prepared will be available to other investigators.

SUPPORTED BY Connecticut State Government - Hartford

3.0026, VIBRIO PARAHAEMOLYTICUS IN CHESAPEAKE BAY - ISOLATION, INCIDENCE AND PATHOGENICITY

R.R. COLWELL, Georgetown University, School of Arts, *Washington, District of Columbia* 20007

This project will continue an investigation of the incidence and pathogenicity of the bacterial pathogen 'Vibrio parahaemolyticus' in marine and estuarine animals, with particular emphasis on the Chesapeake Bay blue crab, 'Callinectes sapidus'. The animals, sediment and water will be sampled periodically and any resulting bacteria will be identified. Information on the natural flora of estuarine and marine invertebrate animals will be collected in a format suitable for computer analysis so as to provide a basis for understanding the interaction amongst the micro-organisms constituting the commensal flora. The pathogenicity of any 'Vibrio parahaemolyticus' isolates for crabs, shrimp and mice will be determined.

SUPPORTED BY U.S. National Science Foundation

3.0027, PATHOLOGY RESEARCH

M.M. SIGEL, Univ. of Miami, Variety Childrens Hospital, *Miami, Florida* 33155

1. Continuation of studies on lymphocystis virus and GFA infections in fish tissue culture. This phase of the work includes assessment of the effect to temperature and inhibitors. Attempts are being made to demonstrate the presence of other viruses in certain lesions of fish and invertebrates.

2. Having demonstrated antibacterial and antitumor activity in extracts of several species of marine invertebrates we are pursuing further studies along two lines: a. Isolation and identification of some of the active substances: b. Further assays for biological activity in crude preparations of various species; the assays being directed at detecting anticellular, antiviral, antibacterial, immuno-enhancing and immuno-suppressive activities.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0028, DEVELOPMENT OF METHODS FOR COMMERCIAL PRODUCTION OF FROG LEGS FROM TADPOLES OF THE BULLFROG

D.D. CULLEY, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01445)

OBJECTIVE: Development of rearing methods and facilities for commercial production of bullfrogs (Rana catesbeiana).

APPROACH: Laboratory studies will be set up to determine stocking rates, holding facilities, environmental requirements, feeding techniques, identification and control of diseases and parasites, growth rates and best foods for normal tadpole and frog growth. Efforts will be made to develop techniques for breeding bullfrogs in the laboratory. Techniques and facilities for mass production of living food for bullfrogs will be developed. Various ecological studies of tadpoles and bullfrogs will be made under natural conditions to provide insight into rearing problems encountered in the laboratory.

PROGRESS: Five goitrogenic materials were tested to determine their ability to inhibit metamorphosis of tadpoles, but not growth. Even though one goitrogen seems to have promise, the results were inconclusive because control tadpoles stocked at very low rates grew equally as well. In both cases the tadpoles were 2.5 times the size of normally metamorphosing tadpoles. Young frogs (150) emerging from the test tadpoles were retained and raised in the laboratory to determine if exposure to goitrogens while in the tadpole stage would produce any adverse effects on the developing frogs. No adverse effects were observed in the test animals or the controls. No differences could be detected in growth rates, food conversion, incidence of disease or behavior patterns. Techniques for mass production of bullfrogs were developed. Food conversion of the bullfrogs was equal to or superior to that of agricultural animals. The frogs emerging from the oversized tadpoles were larger and less fragile than frogs emerging from the normal but smaller tadpoles. Frogs obtained a marketable size in eight months. Two of six foods tested proved to promote excellent tadpole growth. A technique and facility for rearing tadpoles under crowded conditions was developed and successfully tested.

SUPPORTED BY Louisiana State Government - Baton Rouge

3.0029, UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES

J. VANLEPIK, Louisiana State University, Graduate School, *Baton Rouge, Louisiana* 70803

Louisiana State University will continue a study of Barataria Bay for the purpose of defining the dynamics of the marsh ecosystem as a precurser to management and utilization. A subproject will involve the study of productivity and bio-degradation of marsh grass as these processes relate to estuarine food chains and to development of diet rations for the aquaculture of shellfish. A related aquaculture project will continue investigations into limiting factors, including nutrition, food habits, spawning cycles and parasitic enemies of pompano.

Legal studies will continue evaluation of legal regimes related to marsh and estuarine utilization, and a course for graduate degrees in marine law will be developed.

Economic research will be directed to a methodology whereby economic data can be reviewed and evaluated in terms of future planning and management for coastal resources.

An inventory and synthesis of environmental data will be conducted jointly with the U. S. Army Corps of Engineers and Sea Grantees.

Northwestern State University, in a subproject, will investigate microsporidiosis, an epidemic disease of commercial shrimp.

SUPPORTED BY U.S. National Science Foundation

3.0030, ENVIRONMENTAL STUDY

F. KIRCHEIS, State Dept. of In. Fish & Game, ***Augusta, Maine*** 04330

Objectives: This job aims to study the environmental characteristics of Floods Pond in regards to its physical, chemical and biological relationships.

Procedure: A Secchi disc will be used to determine transparency and water color will be made by visual examination upon a white background. Both of these tests will be made three times a year, spring, summer, and fall, at permanent sampling stations. The bottom types will be mapped using SCUBA divers and a Petersen bottom sampler. Results will be plotted on a bottom contour map. The shoreline will be typed as to slope, vegetation and development. The geology of the area will be described from U.S.G.S. survey maps of the area and from visual observations. A chemical profile will be made of Floods Pond four times during the year. The studies will be conducted in the deepest part of the pond, and at other locations to be determined at a later date, and will be taken after ice out, during August, just before freeze-up, and during the winter after freeze-up. The tests to be made are: temperature profile at one foot intervals; dissolved oxygen at the surface, bottom, above, below and in the thermocline, if present; carbon dioxide, pH, and total alkalinity at the same levels that D.O. is measured. Certain other chemical characteristics are monitored by the Bangor Water District at their intake pipes and these findings will be made available. Vegetation samples will be taken with an Ekman dredge and a plant hook to determine abundance and distribution of different aquatic plant species. A type map will be prepared. A sample collection of plankton will be made in the late spring to determine species present. No attempt will be made to measure abundance. Fish species present will be determined by sample netting using seines, gill nets and trap nets. Species collected will be classified as either warmwater, coldwater or forage fish and their abundance noted as scarce, common or abundant. Fish samples will be examined for external and internal parasites. The incidence of parasites infecting S. aureolus will be especially noted and their abundance noted.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0031, CHARACTERIZATION OF THE INFECTIOUS PANCREATIC NECROSIS (IPN) VIRUS OF TROUT

B.P. NICHOLSON, Univ. of Maine, Agricultural Experiment Sta., ***Orono, Maine*** 04473 (ME00251)

OBJECTIVE: The investigation involve the elucidation of some of the basic properties of the infectious pancreatic necrosis (IPN) virus of trout. Particular emphasis will be put on those properties which may serve as the base for the development of improved diagnostic and control techniques.

APPROACH: The determination of the effect of infection with IPN virus on the metabolic activities of susceptible cells; the development of any indirect fluorescent antibody (FA) technique to establish more clearly the growth cycle of IPN virus; the clarification of some apparent inconsistencies reported in regard to the effect of metabolic inhibitors on IPN virus; the development of a complement-fixation (CF) test for IPN virus and the investigation of antigenic relationships of several strains of the virus.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

3.0032, MOLLUSCAN MORTALITY STUDIES

F.W. SIELING, State Fish & Wildlife Admin., ***Annapolis, Maryland*** 21404

Objectives: To determine the ranges, prevalence and infection intensities of the major, economically important parasites and diseases affecting the commercial molluscan species found in the Chesapeake Bay and its tributaries. Under field conditions to use the data obtained from the parasite studies To research economically feasible methods of development and management of the oyster '(C. virginica)' resource in mass seed capture and transplantings as well as artificial bed plantings.

Procedures: 1. Field - Field studies will be conducted by the Fish and Wildlife Administration and samples will be collected and delivered to the Oxford laboratory by field personnel from this Agency. No additional expense will be involved for collection and storage of clam samples. 2. Laboratory - Samples of oysters and other commercial species will be collected on a quarterly basis from several areas in Chesapeake Bay and its tributaries. Molluscan samples will be examined in the laboratory. Range and prevalence will be determined for 'Minchinia nelsoni,' Labyrinthomixa marina, Hexami' sp., 'Bucephalus cuculus, Nematopsis ostrearum, Ancistrocoma pelseneeri, Sphenophrya' sp., bacterial pathogens, coccidian sp., parasitic trematodes, cestodes and nematodes, gregarine sp., parasitic copepods, tumorous growths, neoplastic conditions, 'Cliona' and 'Polydora' sp. and other general and specific pathological conditions. An attempt will be made toward predicting mass mortalities of certain mollusks from 'M. nelsni,' 'L. marina' and 'Winter Kill.' Examine samples as collected from non- scheduled areas when indicated, e.g., at times of reported mortalities, in an effort to determine causative agent or agents. Results of all examinations will be used as a guide when determining placement of artificial oyster beds and seed transplants. Compare infection and mortality levels in disease enzootic and non-enzootic areas.

Seasonal spatfall will be monitored in the Manokin River through the use of at least twenty-three spat plate stations. Sixty existing rafts with attached, suspended shell cultch will be used in the off- bottom capture of oyster spat from the Manokin River. Relative efficiencies, merits and disadvantages of spat capture using off-bottom cultch suspended from rafts and on-bottom cultch are to be compared.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0033, SHELLFISH MORTALITY - CHESAPEAKE BAY

C.A. FARLEY, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Oxford, Maryland*

An investigation into the possible causes of shellfish (oyster) mortality in Chesapeake Bay has been initiated.

Intensive sampling of several areas in the Maryland portion of Chesapeake Bay indicated that relatively high mortality levels and MSX (multinucleate sphere of unknown taxonomic position) incidence occurred with regularity in the higher saline waters of Chesapeake Bay near the Virginia-Maryland boundary. Consequently, biweekly monitoring of this area for oyster mortality levels and disease incidence in sampled oysters, as well as to record ecological conditions was begun in April 1961, and continues to present.

Laboratory projects include histological comparisons between the normal and pathological conditions of sampled oysters; isolation and culture of protistan parasites, transmission experiments, identification and life cycle studies of heretofore unrecognized or unidentified pathogens, and histochemical studies aimed toward the elucidation of the biochemical changes that occur in both the parasite and host tissues during infection, and to discover possible rapid and differential diagnostic techniques for parasites in shellfish tissue.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0034, PACIFIC OYSTER MORTALITY STUDIES

A. ROSENFIELD, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Oxford, Maryland*

Efforts are being made to identify or discover those factors, particularly disease agents, responsible for shellfish mortalities on the west coast of the United States and Canada. Epizootiologic and pathologic studies are being conducted to determine timing, patterns, and possible causes of mortalities, and to determine pathogenicity of disease agents. Shellfish from exotic and domestic 'seed' supply areas are screened for micropathogens or disease organisms before introduction or importation of these shellfish into west coast growing areas.

Shellfish from several Far East potential 'seed' sources have been and are being examined microscopically for the presence of microparasites, micropathogens, and disease conditions. Many previously unobserved or unreported microparasites and disease conditions have been seen in these specimens. Reports and appropriate recommendations are sent to pertinent Pacific Coast state agencies, and when deemed necessary, recommendations for quarantines or embargoes on shipments are given.

FISH AND SHELLFISH PATHOLOGY

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0035, REFINEMENT OF MANAGEMENT TECHNIQUES FOR STREAM TROUT LAKES

M.W. JOHNSON, State Div. of Game & Fish, *Saint Paul, Minnesota* 55101

The objective is to improve the percentage of productive lakes among those managed for stream trout, and achieve a higher return to the creel of hatchery stock.

Recommendations made included: stocking in the fall rather than spring; reducing the rate of stocking; stocking at a size of 100 fingerling to the pound or larger; elimination of heavy stockings every two or three years and instead of applying a constant pattern of stocking; restricting the stocking of combinations of brook and rainbow trout to the larger, deeper lakes and reducing the numbers stocked in this case. Recommendations were also made on the selection of new lakes to manage for stream trout and techniques of continued quality control were described.

Problems left unanswered include: 1) The heavy mortality on stocked fingerling rainbow trout after the first year of reclamation; 2) the influence of the rapidly developing populations of minnows and other species that become characteristic of these lakes; 3) parasites, principally Neascus, which infect trout in some lakes and may contribute to fingerling mortality.

In addition to the remaining two problems listed above, it is desirable to continue study of the results of management of different types of lakes.

Explortion into causative factors of fingerling mortality may shed light on the problems of managing the hardwater marl lakes. It has also been thought desirable to institute management on a new softwater lake and compare the results to the hardwater marl lakes and to earlier studies on other softwater lakes.

In summary, the appropriate areas for investigation by this study are: 1. The kind of lakes to manage for stream trout and the kind not to manage. 2. The causative factors of mortality of stocked fingerling trout in these lakes. 3. The role of minnow populations in these managed streat trout lakes.

Procedure: Job. 1 - Measure the differences in trout productivity between three hardwatdr marl lakes and tree softwater lakes, and attempt to identify the factors which cause the differences. Job 2 - Determine the important causes of fingerling mortality in established lakes. Job 3 - Determine the effect of minnows and other non-trout species on the growth and survival of the trout.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0036, EXPERIMENTAL CONTROL OF NEASCUS IN SMALL TROUT LAKES

J.E. MALONEY, State Div. of Game & Fish, *Saint Paul, Minnesota* 55101

Perspective: An unsightly fish parasite known as 'black spot' or 'Neascus' frequently affects some of our more popular sport fishes to such a degree that they are esthetically unacceptable to the angler. The black spots are seen just under the skin and are occassionally within the flesh of the fish. Each spot is a larval cyst of a parasitic strigeid fluke (trematode). This parasite is not transmissible to humans and does not affect the edibility of the fish, but the unsightly appearance of a badly infected fish is quite unappetizing.

Although Neascus seems to have little effect on the health of most fishes, it is suspected that it has caused the recent heavy mortalities of fingerling rainbow trout (Salmo gairdneri) that are stocked annually in Pleasant Lake, Crow Wing Co. The small resident fish species, such as the fathead minnow (Pimephales promelas) and the western banded killifish (Fundulus diaphanus), are very heavily infected with Neascus in Pleasant Lake. Shortly after stocking, the rainbow fingerlings also become infected with Neascus. While the resident fish seem to survive almost complete encrustation by Neascus, the trout may be more severly affected by even a few parasites, possibly because the much deeper penetration into the flesh affects the vital organs.

Objectives: The objective of this investigation is to develop a satisfactory method of Neascus control by eliminating the fish hosts from the cycle.

Procedure: Job 1. Sample fish population for final check on incidence of infestation. Job 2. Analysis of data and preparation of report.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0037, IDENTIFICATION OF PARASITES AND DISEASES EFFECTING MARICULTURE SPECIES

D.W. COOK, State Marine Conserv. Comm., *Biloxi, Mississippi* 35930

Objectives: To identify the parasites and diseases that may infect and adversely effect species of fish, mollusk, and crustacea during mariculture.

Procedures: A thorough review of the literature on the subject will be conducted. Studies will be made of the parasites and diseases found on mariculture species collected from the Mississippi Sound and Northern Gulf of Mexico. Specimens from ongoing mariculture projects in Louisiana and Alabama will be examined periodically for parasites and diseases developing in the ponds.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

3.0038, TRANSMISSION OF AN OVARY PARASITE OF THE GOLDEN SHINER

R.C. SUMMERFELT, State Dept. of Conserv., *Jefferson City, Missouri* 65102

Objectives: Assess mode of transmission of the protozoan parasite Plistophora ovariae, an ovary parasite of the golden shiner, Notemigonus crysoleucas: 1. Oral transmission (per os). 2. Via spore attachment to the egg membrane. 3. Hereditary (intra-ovum) transmission.

Procedures: 1. Oral transmittion - fry and adults of a source free of this parasite will be exposed to spores by feeding and simply adding to the environment. Exposed fish will be examined for the parasite. 2. Via spore attachment to the egg membrane - freshly spawned fish of a source free of this parasite will be exposed to spores which will attach to the egg membrane. Fish which develop from these eggs will be examined for the parasite. 3. Hereditary transmission - fertilized eggs, embryos and fingerlings from parasitized parent fish will be sectioned to determine if intra-ovum transfer has occurred.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

3.0039, INVENTORY OF WATERS OF THE PROJECT AREA

C.G. BISHOP, State Fish & Game Department, *Billings, Montana* 59101

The objective of this job is to make fisheries surveys of the waters of South Central Montana. Physical and chemical data which can be related to the well-being of fishes will be collected in addition to information on fish populations, fish food organisms and other pertinent biological features. Most of the important and easily accessible waters of the project area have already been surveyed and the information incorporated into the department's stream and lake files. These waters will be resurveyed as needed and as time permits so the information can be expanded and updated. Often the resurvey will serve as an evaluation of management measures such as habitat improvement, regulations and stocking with or without rehabilitation (chemical treatment to eliminate undesirable fish population).

New waters - those on which we have little or no information - will be given high priority. It is important to our fisheries management effort that they be surveyed and their fisheries potential and management requirements determined. Survey procedures are set forth in the Montana Lake and Stream Survey Manual. The information will be recorded on standard survey forms. The extent of any particular survey will depend upon the characteristics of the body of water and the adequacy of sampling gear. It is anticipated surveys during this project year will include, but not be limited to: Stillwater and Bighorn Rivers, if an adequate fish shocker can be obtained, and waters on Beartooth Plateau. Deadman's Basin Reservoir will be netted to check on condition of coho salmon planted in recent years.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0040, ETIOLOGY OF ESTUARINE FISH DISEASES

J.B. MAHONEY, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, ***Highlands, New Jersey*** 07732

When a disease occurs, data will be secured on its start and duration, geographical distribution, kinds and size-range of species infected, water conditions including temperature, salinity, dissolved oxygen, pH, and tide and weather conditions. Data on local ecological conditions will be analyzed to determine the role of environment in the disease. Diseased fish will be collected for tests to determine the causative agent of the epizootic. Water samples from the area will be tested to detect the presence of toxic chemicals. Pathogenicity of microorganisms suspected as causative agents will be tested in healthy fish.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0041, RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT FINGERLINGS TO FURUNCULOSIS

R.F. DUMAS, State Conservation Department, *Rome, New York* 13440

Objective: To determine the resistance to furunculosis of selectively bred brook and brown trout fingerlings.

Procedure: Standardize all 'living' factors of all selected strains up to the time of the challenge to remove environment as a possible variable. Regulate the folllowing to remove them as variables: a. Size of the trout in each--none to vary beyond 1/2' of mean. b. Density of trout in aquaria (lbs/ft. 3H2O). c. Water flow (gals/min.). d. Temperature of water--held by thermostat at 58-60 degrees F. for brook trout and at 64-65 degrees F. for brown trout.. e. All strains of pathogens used in the first challenge shall be used in subsequent challenges. f. Each test aquarium of trout shall receive an equal volume of equal density of pathogens, i.e. contact infection. g. Each test aquarium of trout shall be exposed to the pathogens for two hours, plus or minus ten seconds, on two successive days. h. No selected strain fingerlings shall have had a history of pre-test exposure to furunculosis. i. Each sepearte challange shall include a control group of trout which have undergone no selection for furunculosis resistance. j. Each selected brook or brown trout strain shall be challenged in triplicate during fingerling stage.

The biological attribute under study, immunity, will be measured in terms of the logarithm of time to 50% death of the test group. This value, expressed in hours, is designated as ST50. Where this value is unattainable (less than 50% deaths frequently occur in brown trout testing), the 'percent loss or survival' is used to rank the strains.

The virulence of the pathogen will be enhanced before each test by interperitoneal inoculation of susceptible trout and subsequent re- isolation in pure culture. Mass inoculum used in the challenge is prepared by cultivation of the bacteria on nutrient agar (DIFCO 1.5%) in Roux bottles. Bacterial cells will be harvested in spring water. During the period of testing, strict surveillance will be maintained around the clock to gather accurate death time and numbers. These data are carefully tabulated and turned over to Prof. Carl Lowe, Geneticist, of Cornell University for statistical analyses, proper strain evaluation and genetic interpretation. (Text abridged).

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0042, RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT YEARLINGS TO FURUNCULOSIS

R.F. DUMAS, State Conservation Department, *Rome, New York* 13440

Objectives: To determine the resistance of selectively bred strains of brook and brown trout yearlings to furunculosis.

Procedure: The brook and brown yearlings are adjusted to comparable numbers or densities in their pond segments in the spring.

Initial furunculosis exposure each spring results from placing furunculosis-killed trout (from the revitalization of pathogens from the fingerling challenge) into the water being supplied to the yearlings and older trout. The resulting moribund trout are examined to insure that death is the result of furunculosis. From then on, fresh dead trout are daily placed in the water supply and the previous bodies removed.

Further infection results from feeding the ground bodies of the fingerling challenge mixed in the feed. Also, the excess cultivated pathogens slurry from the fingerling challenge is trickled into the yearlings and older water supply. This is done throughout the summer.

The final induced infection results from the total fingerling infection process since the water from the fingerling troughs flows directly into the ponds holding the yearlings and older trout.

Accurate mortality records are kept and these data are used to indicate the yearling performance which is expressed on bar graphs as percent survival. These yearlings are then retained as future brood trout.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0043, FIELD TESTING OF SELECTIVELY BRED STRAINS OF BROOK AND BROWN TROUT UNDER PRODUCTION HATCHERY CONDITIONS

R.F. DUMAS, State Conservation Department, *Rome, New York* 13440

Objectives: (1) To determine if the selected laboratory-proven traits will prevail under production hatchery procedures. (2) To determine if the brook and brown trout strains, bred to display selected traits, still retain the characteristics of 'good' hatchery trout.

Procedures: Contacts are made with production hatchery personnel to thoroughly explain the value of the selected strain and to request their assistance in carrying out successful studies. The total number of strains and production hatcheries involved will vary from year to year.

In order to gather the minimum comparative data, participating product on hatcheries are urged to comply with the following design when raising a selected strain in comparison with one of their own 'native' strains: a. Sac fry and fry of both strains to be as close in age as possible. b. Trout densities to be equal after 1 plus inches and position in holding unit series to be identical. c. Same water supply, flow, temperature and diet for both groups. d. Records of diet, growth and mortality should be monthly and as complet and accurate as possible. e. If prophylactic treatments for ectoparasites, fungus, or gill disease are part of the standard practice--and only furunculosis resistance is being tested--then treat the selected strain along with the 'native' strain. f. If treatments are required for any of the diseases or ectoparasites for which strain resistance is being tested, contact this laboratory before starting this medication. g. Monthly or periodic performance reports are desired, with a final report covering general behavior at the termination of the study. h. If the strains are to be carried into or through the yearling stage, the participating production hatchery is urged to continue the comparative study.

The project biologist from this laboratory will make periodic visits to the participating hatcheries to offer assistance and guidance, as well as disease diagnosis if disired.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0044, ANALYSIS OF DATA AND PREPARATION OF MANUSCRIPTS FOR PUBLICATION

R.F. DUMAS, State Dept. of Env. Conserv., *Rome, New York* 13440

Objective: To prepare the results of the furunculosis testing program for the years 1963-71 for publication.

Procedure: Write and present the collective data on all phases of the testing program and the results of the testing program for publication in various periodicals.

FISH AND SHELLFISH PATHOLOGY

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0045, CYTOLOGY OF VIRAL NEOPLASMS OF FISH

R. WALKER, Rensselaer Polytechnic Inst., Graduate School, *Troy, New York* 12181

Work will be continued on virus-associated skin warts of fish: A. Lymphocystis disease is fairly well known in its middle and late stages. Recent work here on the ultrastructure of the penetration of the virus into connective tissue of the sunfish focuses attention on the fuzzy outer layer of the virion's coat. Enzymic or detergent (etc.?) degradation of this outer layer will be followed by studies of altered infectivity in the normal host and in other species. B. A membrane- budded virus superinfecting lymphocystis giant cells of sunfish has been studied by electron microscopy. This will be described as an 'orphan' virus. Suspicion of its origin from Tubifex feeding has led to finding of virus-like particles in Tubifex from a trout hatchery. This lead will be followed by electron microscpy of the worms. If the virus is repeatedly found, attempts will be made to initiate infection in sunfish, trout, and other species. C. The localized presence of surface-budded virus in both dermal sarcoma and in epidermal hyperplasia of Stizostedion has again been confirmed this spring. The viruses are presumably different, but this August we will have access to a supply of Stizostedion fingerlings for experiments on the tissue specificity of these two viruses. The experiments will be controlled by electron microscopy.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

3.0046, BACTERIAL FLORA OF APPARENTLY HEALTHY STRIPED BASS (ROCCUS SAXATILIS) & ITS CORRELATION WITH THE BACTERIA OF THE HATCHERY WATER SUPPLY

C.W. OREAR, East Carolina University, School of Arts, *Greenville, North Carolina* 27834

Assays of the bacterial flora of striped bass (Roccus saxatilis) and its environment will provide information that can be used to understand better the complex factors involved in fish bacterial diseases and the total environmental relationship of fish. Numerical characterization to assess phenotypic similarity of isolates will provide a means of determining the relatedness among the isolates from fish and water.

The student investigator will be expected to help develop proper techniques for isolation and culture to provide information neded for numerical analysis.

SUPPORTED BY No Formal Support Reported

3.0047, PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA

G.C. MILLER, Univ. of North Carolina, Agricultural Experiment Sta., *Raleigh, North Carolina* 27600 (NC03291)

OBJECTIVE: Study the ecology and life histories of parasites in our native fresh-water fishes, especially those of economic importance and their possible relationship to man and his domesticated animals.

APPROACH: Host animals from various parts of the state will be collected and studied for the prevalence of parasitism. These host fishes will be collected by the use of setpoles, trotlines traps, angling, netting and seining. In addition, some hosts may be obtained from the North Carolina Wildlife Commission and the North Carolina Cooperative Fishery Unit. Fishes from lakes, ponds, and streams will be examined to study the effect of environmental influences on parasite burden in the host. Some smaller, non-game fishes are directly implicated in the life histories of parasites of some economically important hosts. Parasitic helminths, leeches, and copepods will be the primary organisms investigated but protozoans also may be included if they show significant parasitism.

PROGRESS: This project was just initiated in October, 1969 and therefore there is little to be reported at this time. Contacts were established with fishery biologists at Lake Norman and at Kerr Scott Lake. Samples of various species of fishes were surveyed from both lakes to determine the incidence and types of parasites in these hosts. Lake Norman especially offers some unique possibilities. The presence of the Duke Power Plant and its associated thermal 'pollution,' or rather thermal effects, offers an opportunity to study these effects on the parasitic fauna as compared with other parts of the lake and other comparable lakes. Studies have been initiated in this direction. Small samples of fishes from ponds and streams have been surveyed for parasites since it is our intention to identify and determine the importance of these parasites in fresh-water fishes in North Carolina.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

3.0048, RESEARCH VESSEL OPERATIONS

W.V. BURT, Oregon State University, School of Science, *Corvallis, Oregon* 97331

This project provides partial operating support for two research vessels operated by Oregon State University for the Period 1 December to 30 November 1970.

A wide range of research projects will utilize shiptime provided by this grant. Examples of projects are the following: studies of nepheloid layers using optical techniques; studies of seawater chemistry and of interstitial water chemistry at the sediment-seawater interface; studies of parasites of fish and benthos; studies of ecology of nekton in relation to upwelling and Columbia River plume measurement of orbital wave velocities in conjunction with sea and atmospheric turbulence studies.

SUPPORTED BY U.S. National Science Foundation

3.0049, INFECTIOUS DISEASES OF SALMONID FISHES

J.L. FRYER, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00815)

OBJECTIVE: Study the epidemiology and transmission of infectious diseases in populations of fishes with emphasis on certain bacterial agents. Investigate the use of immunological methods for both prevention and diagnosis of fish diseases. Determine the source of infection, life history and means of transmission of infectious protozoa.

APPROACH: The above objectives will be pursued employing standard bacteriological methods and procedures required for the study of infectious diseases.

PROGRESS: Results indicate that fish form significant amounts of antibody when injected with Aeromanas salmoncida or Chondrococcus columnaris. Experiments are now underway in which oral vaccines have been prepared from these bacteria and are being fed to salmon. The purpose of these tests is to determine that disease protection can be conferred to these animals. Results of experiments with endotoxin from A. salmoncida indicate the material is relatively unimportant in the disease process.

SUPPORTED BY Oregon State Government - Salem

3.0050, BIOLOGY OF THE PROTOZOAN PARASITE CERATOMYXA SHASTA

J.L. FRYER, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00908)

OBJECTIVE: Determine the method of transmission of disease to fish. Attempt to discover infectious stage of organisms, describe and define the biological and physical characteristics of infectious agent. Examine possibility of intermediate host, and distribution and impact on populations of fish resulting from infection by organism.

APPROACH: Transmission of disease: Various organisms will be examined as intermediate hosts for transmission of this disease. In addition we plan experiments which will attempt to define the size of the infectious agent responsible for this disease. Once the infectious agent has been defined, we will attempt to describe the biological and physical properties of the organism. Infectious Stage: A great deal of this work will involve filtration of water carrying the infectious stage and the examination of these filters. Distribution and Impact of Intermediate Host: In an attempt to discover the infectious organism we will continue to investigate the geographical distribution of the organism and to examine any material occurring in epizootics caused by this disease.

PROGRESS: The results of the ecological study of Ceratomyxa shasta now clearly indicate that the infectious disease arises from two sources; Crescent and Suttle Lakes in the Deschutes River system of Oregon. The disease enters the Columbia River by way of the Deschutes River system and does not exist in the Columbia River above its confluents with the Deschutes. The only other contributors of the disease to the Columbia system are LaCamas Creek and the Cowlitz River in Washington. The ultra structure of the spore was examined by means of electron microscopy. Experiments dealing with the transmission of this disease have failed to reveal the method by which this occurs.

SUPPORTED BY Oregon State Government - Salem

3.0051, THE RELATIONSHIP OF TEMPERATURE TO DISEASE OF SALMONID FISHES

J.L. FRYER, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00909)

OBJECTIVE: Determine the effect of water temperature on the most important infectious diseases of salmonid fish. Determine effect of temperature on survival of the specific disease agents in Columbia river water.

APPROACH: Experimental groups of fish will be held in individual tanks in groups of twenty-five. Each tank will be supplied with flowing well water maintained at a constant temperature. Temperatures in the range of 38 F to 73 F will be studied. Fish will be inoculated with a pure culture of the pathogen being studied and the number of fatal infections occurring in each temperature group during the appropriate experimental period recorded. In vitro experiments will be carried out with each disease agent by suspending a pure culture in Columbia river water at temperature intervals within the above range and determining the death rate or the maximum survival period for each temperature.

PROGRESS: Notification was received concerning this grant in late May 1969 and the first appointments made in July 1969. Thus far all the effort has gone into a design and installation of a complicated temperature control equipment required for the conduct of these experiments. It is presently estimated by Cornell, Howland, Hayes and Merryfield that installation of the equipment will be complete sometime during April 1970.

SUPPORTED BY Oregon State Government - Salem

3.0052, ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON

H.F. HORTON, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00778)

OBJECTIVE: Provide fundamental understanding of the ecological factors which influence the abundance and well-being of the recreationally important fish species in Oregon estuaries; and develop the understanding of the ecology of the various species into recommendations for management practices. Specific objectives for immediate study are: Determine the seasonal food habits of the white seaperch in Yaquina Bay, Oregon. Determine the kinds and relative abundance of the internal and external parasites to which the white seaperch plays host. Determine the relationships of length to weight, age to length and weight, and fecundity and maturity to age and length, determine the possible existence of coastal races of the species.

APPROACH: Data on length, weight, fecundity and maturity will be determined from specimens collected at two-week intervals. Fyke nets, beach seines, gill nets, otter trawls and angling techniques will be used to capture specimens. Food habits will be analyzed by the volumetric and frequency of occurrence techniques. Parasites will be collected by standard autopsy techniques. Racial analysis will be determined by electrophoretic methods.

PROGRESS: Investigations of the 'Movement and Angler Use of Four Foodfishes in Yaquina Bay, Oregon', and the 'Early Life History and Potential Yield of the Basket Cockle in Netarts Bay, Oregon' were conducted. The first study listed was completed and published by Beardsley (1969). In the study of the basket cockle in Netarts Bay, research was directed toward the following goals: (1) Determining growth and mortality rates of larval and post-larval cockles; (2) examining the effects of environmental variation, including changes in temperature, salinity, and food abundance, on the growth and mortality of cockle clams; (3) attempting to determine the most important environmental features affecting the distribution and abundance of laral cockle clams at the time of setting. To achieve these goals, sediment samples were collected in Netarts Bay from early spring through September, 1969. These samples are now being processed for enumeration and description of bivalve larvae and post-larvae. Samples of mature cockle clams have been collected during the same period of study to determine condition and time of gametogenesis. A vertically integrating plankton pump was constructed and perfected.

SUPPORTED BY Oregon State Government - Salem

3.0053, AQUICULTURE, SALMON CULTURE - RESEARCH

W.J. MCNEIL, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

Release of pink, chum, and chinook salmon from the Netarts hatchery for winter-spring 1970 is scheduled. Total number of fish released is expected to exceed 500,000 and may approach 1,000,000. Studies on effects of salinity and temperature on growth of salmon will be emphasized at Port Orford. Field experiments on cryopreservation of pink salmon sperm will be conducted in Alaska in conjunction with transplantation of eggs to Oregon. Culture of salmon in heated sea water from stem-electric stations and effects of the 'salmon poisoning' parasite on growth of salmon will be studied at the Marine Science Center.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0054, EPIDEMOLOGY OF 'SALMON POISONING' DISEASE

R.E. MILLEMANN, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00657)

OBJECTIVE: Determine the natural definitive host(s) for the fluke and rickettsiae; whether animals, other than canids, experimentally infected with the trematode also harbor the rickettsiae. Determine if fluke eggs and miracidia carry the rickettsiae and are capable of transmitting the disease to susceptible dogs; and attempt to locate the rickettsiae in various fluke stages.

APPROACH: Inject various stages of fluke parasite into susceptible dogs; and use fluorescent antibody technique. Study the relationship between the parasite and fish with emphasis on: Effect in salinity levels on parasites and rickettsiae retention by anadromoun salmonid fish; susceptibility of non-salmonid fish to infection; comparative susceptibility of native and introduced species of salmonids; and levels of infection upon the growth and swimming performance of salmonids.

PROGRESS: Studies on the natural animal hosts for Nanophyetus salmincola were completed and the results published. The etiologic agent was characterized by electron microscopy. Preliminary results have indicated that the agent has been grown in embryonated chicken eggs. Studies on the effects of the trematode on the growth and swimming performance of salmonid fish are being continued.

SUPPORTED BY Oregon State Government - Salem

3.0055, MARINE FISHERIES - SYMBIOSIS AND PARASITISM - RESEARCH

I. PRATT, Oregon State University, School of Science, *Corvallis, Oregon* 97331

The research and training in this section of the marine fisheries project is concerned with the study of the parasites and other symbiotic relationships involving fishes and molluscs in the estuarine and shallow water environment. Included are: a) The identification and study of host-parasite relationships that are potentially harmful, especially under the conditions of aquiculture, b) determination of ecological factors governing the incidence of parasitism in the natural situation, c) study of the role of parasitism in the survival of larval and juvenile fishes, d) and a study of the symbiotic relationship between an unicellular alga and the cockle clam. We are also available for the study of epidemics that may occur in laboratory experimental tanks and ponds. The species of fishes under study include starry flounder, rex sole, English sole, several species of the embiotocid perches and rockfish.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0056, MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT

R.O. SINNHUBER, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00859)

OBJECTIVE: Quantitate the carcinogenicity of ingested aflatoxins B(1), B(2), G(1) and G(2). Investigate the possible synergistic activity of combinations of the four aflatoxins in the induction of hepatoma in rainbow trout. Determine the effect of certain mold metabolites on the dose-response to aflatoxin-induced hepatoma. These would include kojic acid, aspergillic acid and fungal products of related chemical structure. Determine the acute toxicity of aflatoxins B(1), B(2), G(1) and G(2) to rainbow trout.

APPROACH: Rainbow trout (Salmo gairdnerii) will be used as the principal test animal for this project; however, other test animals such as rats or mice may be included as the work dictates. Past work with the rainbow trout, and in particular the Mt. Shasta strain, has shown it to be extremely sensitive to aflatoxin. These fish will be hatched at our laboratory and reared in disease-free, filtered water with complete control of dietary intake. A basal test diet of vitamin-free casein, gelatin, dextrin, minerals and vitamins found to be very satifactory in previous experiments, will be used as the medium for feed test substances. Feed consumption and growth rate will be measured during the experimental period usually 20 months.

PROGRESS: The acute toxicity of kojic acid, a mold metabolite, which accompanies aflatoxins in most mold cultures was determined in rainbow trout and found to be 12.36 mg/kg by I.P. Two other species gave similar results. Chronic feeding studies with aflatoxin B(1) are in progress. The evaluation of the carcinogenicity of aflatoxin M(1) is showing this compound, which is a metabolite of B(1), to be a powerful carcinogen. This compound is found in the milk and urine of animals consuming B(1). A number of other mold metabolites provided by the Food and Drug Administration are under test, these include: aspertoxin, sterigmatocystin, ochratoxin and patulin.

SUPPORTED BY Oregon State Government - Salem

3.0057, IMPACT OF CERATOMYXA IN CENTRAL OREGON SALMONID POPULATIONS

J.L. FRYER, State Fish Commission, *Portland, Oregon* 97201

Objectives: Determine the geographical distribution of the disease within the Deschutes Basin and specificity of some salmonid species.

Procedures: (1) To define the distribution of the organism and to observe where it may have been spread into areas formerly free of the disease, a survey will be continued. (a) This will be accomplished by exposing uninfected fish at selected sites in rivers and lakes and then examining these animals for presence of the disease. (b) Various species of salmonids will be liveboxed to determine specificity of the organism.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0058, TRANSMISSION OF CERATOMYXA SHASTA

R.G. HERRIG, State Fish Commission, *Portland, Oregon* 97201

Objectives: Determine the method by which the disease is transmitted to fish, find the infectious stage of the organism, examine the possibility of an intermediate host, describe and define the biological and physical characteristics of the infectious agent.

Procedures: 1. Conduct transmission experiments utilizing spores. 2. Establish laboratory scale experiments designed to induce a natural infection under controlled conditions. (Use water and sediments from areas containing infectious agent.) 3. Determine infectious stage of the disease. 4. Examine other vertebrate and invertebrate forms from Central Oregon waters, as a possible intermediate host. 5. Determine size of the agent by passing infectious water through fileters.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0059, IMPROVEMENT OF SALMON AND STEELHEAD TROUT HATCHERY TECHNIQUES

E. PULFORD, State Fish Commission, *Portland, Oregon* 97201

Conduct work connected with the operation of salmon hatcheries and specifically in the areas of Hatchery Practices, Infectious Diseases, and Nutrition-Physiology.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0060, MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST

C.D. SNOW, State Fish Commission, *Portland, Oregon* 97201

Summary of Proposed Work: The Oregon Fish Commission is continuing the oyster mortality monitoring program begun in 1966 with slight changes to conform with the recommendations of the team of experts which reviewed the program in 1968. Sampling stations will be maintained in Tillamook, Yaquina and Coos Bays.

In Yaquina Bay, the number of sampling stations will be reduced from six to three to permit more intensive monitoring of both native and Pacific oysters. Observations will be made every two weeks, and samples will be collected every 4 weeks. Those and dead or abnormal oysters will be sent to the University of Washington for histological examination.

In addition to the sampling stations in Yaquina Bay, an observation station will be established at the dock of the Marine Science Center. Observations will be made each working day. Dead or moribund animals will be collected for histological examination.

There will be one station at Tillamook and Coos Bays. Sampling will be monthly with collections for histological examination from the control lots and the adjacent beds.

Water quality measurements at Yaquina Bay will include temperature, salinity, dissolved oxygen and turbidity plus supplemental information from the Federal Water Pollution Control Administration and Oregon State University. At Tillamook and Coos Bays measurements of temperature, salinity and dissolved oxygen will be taken during each sampling visit.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0061, VIRAL DISEASES OF MARINE FISHES

D.G. BECKWITH, Lehigh University, Graduate School, *Bethlehem, Pennsylvania* 18015

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Society of the Sigma Xi - New Haven, Conn.

3.0062, USE OF CELL CULTURE METHODS TO ATTEMPT TO FOLLOW DEVELOPING STAGES OF SPORES

J.M. MCKINNEY, State Fish Commission, *Harrisburg, Pennsylvania*

Objective: Fish cell culture techniques have recently been well developed by Dr. Ken Wolf at the Eastern Fish Disease Laboratory at Leetown, West Virginia. Numerous organisms have been grown in mammalian cell lines over the years. Previous research with protozoans such as coccidia indicates it may be possible to culture some phases of Myxosoma cerebralis in cell and tissue culture. The objective of this phase will be to explore the possibilities of cultivating stages of the parasite in cell culture.

Procedure: It may be necessary to utilize members of the Genus Myxobolus to carry out preliminary phases of this work. The Genus Myxobolus is a sporozoan very similar to Myxosoma but it has some facets which makes it advantageous for tissue culture work.

The Myxobolus cysts containing spores can be removed intact from the host organism. The cyst will then be disinfected externally to exlude any bacteria from them. After the cyst has been disinfected it will be placed in sterile saline to be homogenized.

These spores will then be subjected to various treatments such as aeration, pH changes, and temperature changes in an attempt to develop stages that may be infective. These possibly infective stages will then be added to tissue culture media in which a fish cell line is being propagated. The final goal will be the actual development of the vegetative phase of the organism in cell culture. Information gained from working with Myxobolus will be used to attempt similar culturing techniques with Myxosoma cerebralis spores.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0063, SUSCEPTIBILITY OF VARIOUS AGES OF FISH TO INFECTION

J.M. MCKINNEY, State Fish Commission, *Harrisburg, Pennsylvania*

Objective: It is the purpose of this phase to develop a pattern of susceptibility that will hopefully reveal an age at which fish are most vulnerable to the disease.

Procedure: As soon as an infection can be established, fish of predetermined ages will be introduced into infected water and records will be kept to determine which age group is most susceptible. In addition, trout eggs will be incubated in water containing whirling disease to determine if the eggs can become infected prior to hatching. Results from recent experiments undertaken at the Eastern Fish Disease Laboratories at Leetown, West Virginia have proven that sac fry become infected prior to feeding while the esophageal plug is still intact.

If the age relationship to susceptibility is established it may be feasible to control the disease by quaranteening lots of fish during the period of susceptibility. This segment of the project will be seasonal depending on the availability of young trout. Most of this work will be done during the early months of 1970.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0064, UTILIZATION OF INVERTEBRATE VECTORS IN THE TRANSMISSION OF WHIRLING DISEASE

J.M. MCKINNEY, State Fish Commission, *Harrisburg, Pennsylvania*

Objective: To ascertain the importance of invertebrate vectors in the transmission of whirling disease. At the present time it is not known for sure if invertebrate vectors are necessary for the transmission of this disease. Present evidence suggests they are not involved but it is quite common for such vectors to be associated with the life cycles of many of the parasitic worms found in fish.

Procedure: Recent experiments undertaken by the Eastern Fish Disease Laboratory at Leetown, West Virginia rule out the importance of vertebrate vectors in the transmission of whirling disease. This job is hereby deleted from the project.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0065, USE OF TISSUE SECTIONING TECHNIQUES TO ATTEMPT TO FOLLOW THE LIFE HISTORY OF WHIRLING DISEASE PARASITES FROM THE FIRST DAY OF INFECTION

J.M. MCKINNEY, State Fish Commission, *Harrisburg, Pennsylvania*

Objective: In order to be able to completely understand the development of this disease in fish it would be desirable to follow the parasite through all stages in the fish. Due to the small size of the spore and vegetative forms the only method of observing the parasite in the fish is through histological sections. Attempts will be made to find the vegetative stages as well as spores in the various trout tissues.

Procedure: Young fry will artificially infected if feasible or will be held in water known to be contaminated with spores of Myxosoma cerebralis. At daily intervals some of the fry will be removed and placed in a fixative for future histological work. After the specimens have been collected they will be sectioned and placed on individual slides. The various organs and tissues will be observed to check with the presence of tropozoites and spores.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0066, TREATMENT OF WHIRLING DISEASE SPORES TO PRODUCE INFECTIVE STATES OF THE ORGANISM

J.M. MCKINNEY, State Fish Commission, *Harrisburg, Pennsylvania*

Objective: To subject whirling disease spores to various treatments and conditions in an attempt to learn more about how the spores become infective. Such information is needed to be able to produce laboratory infections on a regular basis.

Procedure: Spores will be taken from infected fish and subjected to various treatments. One treatment will be the aging of spores. Some researchers believe it necessary for the spores to remain dormant for an undetermined period of time before they will produce infective stages. For this reason, the spores will be subjected to refrigeration, freezing, elevated temperatures and other environmental conditions. Following such treatments, the viability of the spores will be tested using a YSI Biological Oxygen Monitoring System which will measure the respiration of the spores. The development of this system as an assay tool will hopefully provide a practical method for determining the efficiency of disinfecting procedures.

Work Schedule: We will continue the work started in phase II in an effort to infect fish with collected spores. To date we have not been able to produce infections on a regular basis. We will continue to work with the Eastern Fish Disease Laboratory at Leetown, who we understand has made progress in effecting a system of laboratory infections on a regular basis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0067, METHODS OF COLLECTING AND CONCENTRATING SPORES TAKEN FROM INFECTED FISH

J.M. MCKINNEY, State Fish Commission, *Harrisburg, Pennsylvania*

Objective: To determine effective methods of obtaining an adequate number of spores with which to conduct further experiments.

Procedure: The spores of Myxosoma cerebralis have been successfully concentrated by centrifugation. Future experiments will be designed to purify spore concentrations by eliminating extraneous suspended matter from solution. Density-gradient sedimentation, centrifugation, and/or the decomposition of protein by enzymatic action will be utilized to achieve this goal.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0068, DETERMINE IF SPORES OR INFECTIVE STAGES ARE SHED FROM LIVING FISH

J.M. MCKINNEY, State Fish Commission, *Harrisburg, Pennsylvania*

Objective: At the present time it is not known if infective stages of whirling disease are shed before the fish dies. This phase of the study will attempt to prove if the infected fish can transmit the disease to other fish prior to their death. Three methods will be employed to achieve this goal.

Procedure: 1. An attempt will be made to collect infective units by filtering diluted fecal samples through filters of known pore size. This will assist in determining the size of the infective stages. Trout fry will be exposed to the filtrate to determine its infectivity. 3. Attempts will be made to isolate stages of M. cerebralis from the peritoneal cavity. Physiological saline will be injected into the cavity and the washings withdrawn into the syringe. The material will be examined microscopically for stages of the parasite.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0069, MULTIPLICATION OF ENTERIC VIRUSES IN SHELLFISH

P.W. CHANG, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881 (RI00404)

OBJECTIVE: Determine whether or not: Enteroviruses can multiply in the tissues of marine shellfish; enterovirus receptors are demonstrable in any shellfish tissues. Determine nature of viral receptors in shellfish tissues if such receptors exist.

APPROACH: The methods outlined in this study are designed to circumvent the difficulties encountered by previous investigators in evaluating whether virus measured in shellfish tissue represents persisting input virus or virus formed De Novo. These methods include the use of proflavine labelled virus, electron microscopy of infected tissue. The shellfish tissues will also be examined for viral receptors.

SUPPORTED BY Rhode Island State Government

3.0070, MARINE FISH-CULTURE PATHOLOGY

R. WOLKE, Univ. of Rhode Island, Graduate School, *Kingston, Rhode Island* 02881

1. To develop and staff a diagnostic and research histopathology laboratory at the University of Rhode Island for investigation of the disease of marine organisms of commercial importance (fish and shellfish). 2. To obtain a qualitative and quantitative survey of the disease of fish in the marine and freshwater environments of Rhode Island and those associated with aquaculture projects within the State. 3. To obtain an estimate of these diseases on the fisheries ecology. 4. To provide normal and abnormal histological sections of various species of fish that may serve as base data for future research and teaching purposes. 5. To collect (as a task force member of the International Congress Against Cancer) neoplastic lesions of bottom-feeding marine fish.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0071, THE EFFECTS OF DIFFERENTLY EXTRACTED ENDOTOXINS FROM ESCHERICHIA COLI ON RAINBOW TROUT (SALMO GAIRDNERI)

G.P. OLEARY, Providence College, Graduate School, *Providence, Rhode Island* 02908

The proposed research involves a laboratory study on the possible lethal and side effects of bacterial endotoxin on rainbow trout. The investigation will be conducted using endotoxin extracted from the water pollutant organism Escherichia coli. The endotoxin will be extracted by four mild extraction methods thought to give endotoxin- lipopolysaccharide preparations more closely related to the natural state found associated with the living organism. The four extraction procedures will be a ethylene diaminete traacetic acid (EDTA) method, a water method, a trichloracetic acid method, and an aqueous ether extraction method. The extracted endotoxin will be administered to the rainbow trout by intraperitoneal, and intravenous injections in an aqueous solution.

The lethal effect of the endotoxin will be measured by the amount (microgram of endotoxin per gram body weight of trout) necessary to cause a 50% death rate (LD50). Other physiological effects due to endotoxemia besides LD50 measurements will be noted and measured where possible for correlation with endotoxin effects on animals.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

3.0072, WALLEYE AND NORTHERN PIKE STUDY

J.E. CRABTREE, State Parks & Wildlife Dept., *Austin, Texas* 78701

Objective: To determine for walleye and northern pike in Texas waters: 1. Food habits, 2. Reproductive habits, 3. Age and growth, 4. Seasonal distribution and movements, 5. Presence of parasites.

Procedures: 1. Monthly collections of various sizes of fish will be made utilizing gill nets, frame nets, trawls and seines. Collections will be made more often during periods of particular importance such as the spawning period. The stomach contents of specimens taken will be analyzed. Fish foods will be identified to species and invertebrate foods to order, if possible. 2. Determination of spawning sites and time will be made through observations and sampling with nets and seines. Fecundity and age at maturity will be determined from samples taken in number 1 above. 3. Samples taken under number 1 above will be weighed, measured and K-factors figured. Age will be determined by scale annuli counts and by length-frequency studies. Fish of known age will be marked to aid in age-growth determination and in determining longevity. 4. Seasonal distribution will be determined by collecting in each ecological habitat during the month. Records of release sites for marked fish, in number 3 above, will be recorded and compared with returns to determine movements of the marked fish. 5. All samples taken will be examined grossly for the presence of parasites.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0073, SALT WATER POND RESEARCH

W.R. MORE, State Parks & Wildlife Dept., *Austin, Texas* 78701

1. To determine survival rates of spotted seatrout (Cynoscion nebulosus) and black drum (Pogonias cromis) released after capture with various types of fishing gear. 2. To determine correlations between mortality rates and seasons of temperatures in species of fish as listed in 1 above. 3. To measure the effect of salinity on shrimp ecology. 4. To determine the effect of pond size on growth and survival of Penaeid shrimp. 5. To study the feasibility of holding shrimp in man-made ponds during winter for off-season sale as bait shrimp. 6. To evaluate mortalities associated with different fish tagging methods over short and long term periods. 7. To determine loss of tags associated with different tagging methods used on different fish. 8. To determine the best tagging method for individual fish species. 9. To determine if oysters from other bay systems are more resistent to the diseases found in Matagorda Bay. 10. To determine to what extent water depth affects oyster growth and survival in ponds. 11. As time permits, preliminary work on techniques for the propagation of sciaenid fish in the laboratory will be conducted.

SUPPORTED BY U.S. Dept. of Interior - Bu. Comm. Fish.

3.0074, BACTERIAL AND VIRAL DISEASES AND CELL CULTURES OF MARINE FISH AND SHELLFISH

G.W. KLONTZ, Texas A & M University System, Sea Grant Program Office, *College Station, Texas* 77843

The continuing objectives of this project are to study the bacterial and viral diseases enzootic to wild and propagated fish and shellfish in the Gulf of Mexico. The Program is broad-based to encompass the following: 1) Detection and characterization, in vitro as well as in vivo, of bacteria and viruses pathogenic for marine fish and shellfish; 2) Epizootiological studies to determine the significance of the isolated disease-producing agents; 3) Diagnostic services for private and governmental agencies; 4) Professional training at the graduate level for qualified students-both veterinarians and fisheries biologists.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0075, A HISTOPATHOLOGICAL STUDY AND DESCRIPTION OF ACUTE INFLAMMATORY RESPONSE IN SPECKLED TROUT (CYNOSCION NEBULOSUS)

R.M. ROBINSON, Texas A & M University System, Sea Grant Program Office, *College Station, Texas* 77843

The purpose of this experimentation is to provide basic research data on the histopathological changes involved in acute inflammation in the fish. These presently unavailable data are imperative to pathological interpretation of lesions induced by various mechanisms as they relate to spontaneous and experimental diseases.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0076, A HISTOLOGIC STUDY OF MARINE FISH

R.F. SIS, Texas A & M University System, Sea Grant Program Office, *College Station, Texas* 77843

In an attempt to solve the food shortage in the world, an increasing number of investigators are studying the diseases of food- producing fish. There is a particular need for base line studies in microscopic anatomy of fish in support of the research of fish diseases. This project will study the gross and microscopic appearance of tissues and organs of fish from the Gulf of Mexico. Information will be obtained on the comparative histology of different species of fish to be used for experimentation by marine fish investigators in the College of Veterinary Medicine at Texas A&M University. Such a description will be valuable in determining the normal and abnormal appearance of fish tissue when studying fish diseases. This investigation will contribute to our knowledge of comparative histology and provide a collection of histologic material for future teaching and research.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0077, TESTING OF STOCKS OF OYSTERS FOR DISEASE RESISTANCE

J.D. ANDREWS, State Marine Resources Comm., *Newport News, Virginia* 23607

The objective of this phase is the determination of degree of disease resistance of selected stocks of oysters.

Selected stocks of potentially resistant oysters have been placed in locations where disease is known to be active. Testing of these stocks will be continued and new stocks added to the program.

Susceptible oysters will be imported at appropriate times for the purpose of assessing the level of disease activity. Levels of infection will be followed by periodic sampling and examination of tissues for presence of MSX, Dermocystidium, and other disease agents. Mortalities will be followed by means of standard tray techniques. New generations will be added to the testing program.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0078, ACQUIRED VS. GENETIC RESISTANCE IN OYSTERS

J.D. ANDREWS, State Marine Resources Comm., *Newport News, Virginia* 23607

Our attention has been focused on acquired resistance because it offers a shortcut to resumed oyster production in MSX areas. However, it is apparent that genetic factors are also involved in the resistance and growth of progeny lots. No selection for quality has been permitted to avoid biasing the tests on MSX resistance. For the long term, genetic impovement of stocks is the logical approach and the one intended originally in this program. Progress has been slow for lack of quick laboratory techniques for measuring resistance--immunological tests, for example. Laboratory studies of the disease agents are still unsatisfactory and appear to have been aborted by most laboratories.

Our intention is to continue exploring genetic resistance from the field approach but with at least half the new progeny lots being selected for shape, growth, size and other feasible desirable characteristics as well as for disease resistance. This process will begin in the hatchery and be followed throughout the life span of a brood. Improvements in hatchery techniques of conditioning, spawning and rearing are occurring rapidly. The advent of free spat will permit handling many more young oysters than formerly and small lots have been considered a handicap in genetic studies.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0079, TESTS OF SELECTED SEED OYSTER STOCKS ON COMMERCIAL BEDS

J.D. ANDREWS, State Marine Resources Comm., *Newport News, Virginia* 23607

The objective of this phase is to determine whether the same results can be obtained with pilot scale commercial plantings as with controlled tray studies.

Native seed oysters from both an area where they have been exposed to disease (MSX) and one where they have not will be planted on commercial oyster bottoms in a heavily infected area. Both groups of oysters will be monitored for MSX and control trays maintained.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0080, HISTOPATHOLOGY OF LAHONTAN CUTTHROAT TROUT

L.M. ASHLEY, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Cook, Washington*

Sick or moribund fish will be examined histopathologically for evidence of tissue and organ pathology indicative of anemia, degenerative and other diseases. Stained histological sections, tissue imprints and smears will be made as part of a diagnostic effort. Infectious disease materials will be forwarded to the Western Fish Disease Laboratory in Seattle for diagnosis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0081, HISTOPATHOLOGY OF LIVERS OF RAINBOW TROUT FED RANCID PELLETS CONTAINING AFLATOXIN

L.M. ASHLEY, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Cook, Washington*

A histopathological survey of rainbow trout livers, searching mainly for evidence of liver cell carcinoma (hepatoma) and for incidental pathology in trout fed rancid, aflatoxin containing dry pellets fortified with various additives such as a standard vitamin pack, cod liver oil and alpha-tocopherol.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0082, MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST

C. LINDSAY, State Dept. of Fisheries, *Olympia, Washington* 98501

The Department of Fisheries will conduct field and environmental studies on mass mortalities affecting Pacific Oysters as set forth in the following phases: Phase I. Monitoring of Mortality and Growth of Pacific Oyster Seed from 5 Source Areas. 1. Japan, Hokima (High mortality area). 2. Japan, Mongoku-ura (Low mortality area). 3. Washington, Dabob Bay. 4. Washington, Willapa Bay. 5. Canada, Pendrell Sound. Phase II. Float Studies, Eld Inlet. Mortality, growth, fatness, glycogen and histology of 1965 year class (planting) oysters from beds of LeRoy Patterson. Phase III. Transplant Study. Patterson 1965 year class (planting) oysters previously planted at Quilcene Bay, Eld Inlet (Matthews) and Eld Inlet (Brenners) will be transplanted from each station to the other two. Mortality, growth, fatness, glycogen and histology will be monitored. Phase IV. Mortality Monitoring. 1966 (planting) year class Patterson oysters at Case, Eld, and Totten Inlets and Oakland and Quilcene Bays. Phase V. Commercial Oyster-bed Mortality Monitoring. Northern, central, and southern Puget Sound, Grays Harbor, and Willapa Bay. Phase VI. Cultural Experiments to Circumvent Mortalities. 1967 Japanese year class seed planted and reared in Oakland Bay will be transplanted to North Bay. Commercial stocks (1967) reared in North Bay will be used for controls. Phase VII. Hydrographic Sampling. 1. Continuous recording of water temperature adjacent to oyster stocks at the sampling stations in Quilcene Bay, Eld Inlet (Matthews), and Eld Inlet (Brenners). 2. Eld Inlet. A. Center line of inlet. Vertical distribution of salinity, temperature, O2, chlorophyll and phosphate. B. Shallow oyster beds. Photosynthetic rate, chlorophyll, phytoplankton species, pH, temperature, salinity, O2, total and inorganic phosphates, nitrate, nitrite ammonia, soluble and particulate carbohydrates and organic nitrogen, lipids. 3. Quilcene Bay, Oakland Bay, Totten Inlet, and Case Inlet. Salinity, temperature, O2, chlorophyll, phytoplankton and phosphate. Phase VIII. Standardization of Data Collection Processing and Analysis.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0083, EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS

W.J. EBEL, U.S. Dept. of Commerce, Natl. Marine Fisheries Service, *Seattle, Washington* 98102

Supersaturation of dissolved nitrogen in the Columbia River can be a significant factor in the survival of migrating salmonids. Measurements of nitrogen levels from the estuary to the upper

Columbia River have indicated that highest levels were reached in the spring when large volumes of water were being spilled at dams. Nitrogen concentrations, which were sufficiently high to produce gas bubble disease in fish, did not equilibrate in reservoirs between dams. Migrant salmonids using fishways or passing through shallow areas that force them near the surface may suffer mortality from high nitrogen levels.

In conjunction with current fish behavior studies on the Columbia River, experiments are in progress to examine the effect of nitrogen levels on survival of migrating adult salmonids. Salmon in fishways are being inspected for evidence of gas bubble disease, and systematic searches of the river system are being made to obtain samples of moribund fish for clinical examination. Laboratory experiments are planned to determine the effects of nitrogen saturation at different pressures and temperatures on survival of young and adult salmon.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0084, ISOLATION OF VIRUSES FROM FISHES - INVESTIGATION OF FISH EPIZOOTICS OF UNKNOWN ETIOLOGY FOR POSSIBLE VIRUS INVOLVEMENT

D.F. AMEND, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle*, *Washington* 98115

Disease of virus etiology are common to all phyla. Annually, epizootics occur in fish populations that cannot be ascribed to the usual causes such as nutrition, bacteria, protozoa, etc, Some of these occurrences manifest symptoms often associated with a virus disease - abrupt, rapid rise in mortality; rapid death of the individual; lack of response to treatment; and absence of demonstrable cause. These disease are the ones that will be investigated for the presence of viruses.

Suspect material will be processed in a manner affording the virus maximum protection. Portions of filtered (through Millipore HA filters) and unfiltered suspensions will be inoculated into suitable intact animals and tissue cultures. These test systems will be observed for mortalities, morbidity, and/or cytopathogenic changes that indicate disease processes. As a standard, all material will be passed a minimum of three times before it is declared positive or negative in order to eliminate the possibility of low titers being responsible for the negative results or toxin causing the positives.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0085, ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - RED MOUTH COMPARATIVE VACCINE STUDY

D.P. ANDERSON, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle*, *Washington* 98115

Red mouth disease (RM bacterium) in rainbow trout is a serious problem for federal, state and private hatcheries in the Western United States. Vaccine studies have been previously done under this project, and a formula for an effective red mouth vaccine was found to be effective in the laboratory, but difficulty was encountered in field tests.

In this comparative study, an isolate of red mouth is to be prepared by four different vaccine methods. The antigens will be fed, and then the fish sampled periodically for the presence of antibody. Finally, the test and control fish will be exposed to the virulent bacteria.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0086, CYTOPATHOGENIC EFFECT OF TOXIN ON TISSUE

A.J. ROSS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle*, *Washington* 98115

Studies will be conducted on the effect of the toxins on cell cultures.

The role of bacteria in causing the death of fish in many fish diseases is not clear.

In several mammalian diseases, toxins produced by bacteria have been proven to be the mediating factor in the disease process. Methods used to extract toxins from bacterial pathogens of fish. If toxins can be incriminated as the primary cause of death, it may be possible to prepare toxoids which can be used to immunize fish against specific diseases.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0087, CYTOPATHOGENIC EFFECT OF TOXIN IN FISH

A.J. ROSS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle*, *Washington* 98115

Studies will be conducted on the effect of the toxins in fish.

The role of bacteria in causing the death of fish in many fish diseases is not clear.

In several mammalian diseases, toxins produced by bacteria have been proven to be the mediating factor in the disease process. Methods used to extract toxins from these diseases will be used in attempting to extract toxins from bacterial pathogens of fish. If toxins can be incriminated as the primary cause of death, it may be possible to prepare toxoids which can be used to immunize fish against specific diseases.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0088, CORRELATE NITROGEN GAS CONTENT OF WATER SUPPLIES WITH DISEASE

R.R. RUCKER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle*, *Washington* 98115

Excess nitrogen gas in the water of some natural fish rearing areas and some water supplies of hatcheries causes disease. Methods for reducing the gas will be determined. Nitrogen tolerance levels will be determined for fish of different ages.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0089, EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES

G. WEDEMEYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle*, *Washington* 98115

Anadromous fishes may be forced to swim through areas of thermal pollution during their fluvial migration. The effect of such heat stress on the host-defense mechanisms against infectious diseases will be studied using the juvenile coho salmon and steelhead trout.

Fish acclimated to 50F will be subjected to selected heat-stress regimens and changes in those physiological parameters involved in non- immunological disease resistance will be measured. These will include interrenal vitamin C, the 17-hydroxycorticosteroid hormones, plasma proteins, glucose, oxygen levels, and blood buffering capacity.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0090, NUTRITIONAL FACTORS IN THE DEVELOPMENT OF CORYNEBACTERIAL KIDNEY DISEASE

G. WEDEMEYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle*, *Washington* 98115

There is certain evidence that corn gluten as a diet ingredient lowers the resistance of salmonid fishes to corynebacterial kidney disease while cottonseed meal has a protective effect. The Abernathy dry diet made up on an isocaloric, isoprotein basis will be used to test this phenomenon.

The development of the disease will be followed using BUN, glucose, total protein, blood pH, Hb, Hc, interrenal vitamin C, liver glycogen, HCO3 ions and Cl ions to evaluate the effects of the diet on the infection. Diagnoses will be by means of gram-stained kidney smears.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0091, HISTOPATHOGENESIS OF KIDNEY DISEASE

W.T. YASUTAKE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle*, *Washington* 98115

The objective of this study is to describe the histopathogenesis of experimentally induced kidney disease in salmonids. 'Oncorhynchus nerka' will be exposed to the causative agent by feeding and interperitoneal injection. Smears, cultures, kidney, spleen and liver imprints, and Bouin's fixed tissues will be taken weekly for over the period of twelve weeks. Gram stain and routine paraffin embedding and staining technique will be utilized.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0092, HISTOPATHOLOGY OF SALMONID FISHES - HISTOPATHOGENESIS OF CULTUS LAKE VIRUS DISEASE

W.T. YASUTAKE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle*, *Washington* 98115

The purpose of the study is to describe the histopathogenesis of experimentally induced Cultus Lake Virus (CLV) Disease in sockeye salmon (Oncorhynchus nerka) fingerlings.

Samples of 10 fish exposed to a suspension of CLV will be taken every 24 hours for 12 days. Unexposed fish will be taken at the beginning and end of the experiment. Routine histological techniques will be employed.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0093, HISTOPATHOLOGY OF SALMONID FISHES - BACTERIAL RED-MOUTH DISEASE HISTOPATHOGENESIS OF RAINBOW TROUT (SALMON GAIRDNERI)

W.T. YASUTAKE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle*, *Washington* 98115

The objective of this study is to describe the microscopic pathogenesis of bacterial redmouth disease in rainbow trout. The fish will be experimentally infected by direct exposure to diseased fish: Bouin's solution-fixed samples will be taken at intervals. Routine paraffin embedding and staining techniques will be employed. Hemopathological studies of the circulating blood smears and kidney and spleen tissue imprints will be correlated with the histopathological findings.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0094, NEOPLASMS OF SALMONID FISHES

W.T. YASUTAKE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle*, *Washington* 98115

Occasionally during the course of histological examination of experimental and diagnostic specimens, neoplasms have been observed. If and when interesting and/or previously unreported tumors are detected, investigation will be initiated for the possible histopathological identification of the neoplasm.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0095, HISTOPATHOLOGY OF SALMONID FISHES: DIAGNOSIS

W.T. YASUTAKE, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle*, *Washington* 98115

The hematopathologic aspect of IHN as a diagnostic tool has never been investigated. This study will investigate the feasibility of using this technique as a quick presumptive diagnosis method for IHN.

Circulatory blood smears and kidney hematopoietic tissue imprints of IHN infected and non-infected sockeye salmon (Oncorhynchus nerka) and rainbow trout (Salmo gairdneri) will be utilized. Leishman-Giemsa and Wright's stains will be employed.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0096, BACTERIOLOGICAL AND SEROLOGICAL STUDIES ON MOTILE AEROMONADS AND PSEUDOMONADS FRESHLY ISOLATED FROM DISEASED FISHES

G.L. BULLOCK, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Kearneysville*, *West Virginia* 25430

Previous studies on motile aeromonads represented by Aeromonas liquefaciens and oxidative pseudomonads represented by Pseudomonas fluorescens have indicated that the types infecting fish were serologically heterogeneous. In an attempt to define better the types of these two pathogens which infect fishes, strains freshly isolated from diseased fishes will be studied. Although selected morphological and biochemical characteristics will be determined, most of the work will be done on the serological properties of the strains.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0097, DEVELOPMENT OF METHODS FOR RAPID IDENTIFICATION OF BACTERIAL FISH PATHOGENS

G.L. BULLOCK, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Kearneysville*, *West Virginia* 25430

Effective control of infectious diseases among hatchery reared fishes depends on rapid, accurate identification of the infecting agent. In the case of bacterial pathogens new methods, usually used in human or veterinary medicine are being evaluated for their use in fish pathology. These methods usually utilize serological or cultural procedures to rapidly identify the pathogens.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0098, DETECTION OF CARRIER CONDITION IN FURUNCULOSIS

G.L. BULLOCK, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Kearneysville*, *West Virginia* 25430

At present, bacteriological and serological methods are adequate only for detection of acute and chronic furunculosis. It is essential to be able to detect the asymptomatic carriers of furunculosis to avoid introducing the disease into new areas.

The present work involves an attempt to induce furunculosis in suspected carier populations of salmonids. Trout will be injected with sterile filtrate of sonicated A. salmonicida cells or levan, prior to stress, to overcome resistance or immunity to furunculosis.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0099, INFECTIOUS DISEASES OF SOME SALMONID FISHES AND THE ASSOCIATED HISTOPATHOLOGY

R.L. HERMAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Kearneysville*, *West Virginia* 25430

Objective: At the present time there is no satisfactory information on histopathological changes caused by some or most of the infectious fish diseases. This information is needed for accurate diagnosis.

Procedure: This study will be concerned with the histopathology of some of the most common infectious diseases found in hatchery reared salmonids. Experimentally infected fish will be used in order to study daily changes in the progress of the disease.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0100, PARASITOLOGY - PARASITES AND PARASITIC DISEASES OF FISHES - IMMUNIZATION STUDY FOR ICHTHYOPHTHIRIUS

G.L. HOFFMAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Kearneysville*, *West Virginia* 25430

Objective: To infect fish with 'Ichthyophthirius' under controlled conditions.

Procedure: fish will be infected with 'Ichthyophthirius' under controlled conditions, treated and allowed to recover and then challenged with massive doses of Ich to determine if such active immunization is feasible for protecting fish.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0101, ISOLATION AND FURTHER DESCRIPTION OF THE SPORES OF MYXOSOMA CEREBRALIS

G.L. HOFFMAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Kearneysville*, *West Virginia* 25430

Situation: Experimental work on M. cerebralis has been hampered by the difficulty in recovering spores free of fish tissue. The spore was described in Germany in 1904.

Objective: To find a method for the recovery of large numbers of spores reasonably free of fish tissue; such material is needed for research on the disinfection of M. cerebralis. There is some question as to the exact identity of what is known as M. cerebralis from different host fish and different parts of the world. Careful study and description of the spore from these different situations should be made to determine if they are truly identical.

Procedure: The soft tissues of infected fish heads will be digested with pepsin - HCl solution and the digest strained through progressively smaller mesh screens to remove detritus. The hard tissues will be cleaned, washed and the spore 'cysts' dissected from them after which the material will be screened as above. Fresh spores will be sent to Dr. Lom who will prepare electron micrographs of them.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0102, LONGEVITY OF SPORES OF 'MYOXOSOMA CEREBRALIS' (WHIRLING DISEASE)

G.L. HOFFMAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Kearneysville, West Virginia* 25430

Situation: In 1931 Schaperclaus, on circumstantial evidence, stated that the spores survive a long period of time in ponds. Such long survival would make control and eradication very difficult.

Objective: To determine how long the spores survive.

Procedure: Ground up trout heads containing the spores will be placed in 90 gallon fiberglass tanks containing about three inches of mud and supplied with running water. Rainbow trout fry will be added at intervals. If infections occur it will be proof that the spores in the tanks were alive.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0103, IMMUNODIAGNOSIS OF WHIRLING DISEASE (MYXOSOMA CEREBRALIS)

R.E. PUTZ, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Kearneysville, West Virginia* 25430

Objective: At present, whirling disease of salmonids cannot be detected in asymptomatic carrier fish without sacrificing the fish. To determine if whirling disease can be diagnosed serologically a modified indirect fluorescent antibody technique will be tried using a closely related form, Myxosoma cartilaginis from Bluegills as well as M. cerebralis from salmonids.

Procedure: Fish globulin will be prepared by fractionating serum from Myxosoma infected fish using the ammonium sulfate technique. This globulin will be used as an antigen to immunize rabbits in order to get rabbit antiserum against fish globulin. Fluorescent tagged goat antiserum against rabbit globulin will be purchased commercially. After completion of the above, Myxosoma spores will be reacted with the various antisera to see if the indirect fluorescent antibody technique can be utilized as a diagnostic tool for the detection of whirling disease in asymptomatic carrier fish.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0104, VERTEBRATE DISEASES - VIRAL DISEASES OF FRESHWATER FISHES AND OTHER LOWER VERTEBRATES EGTVED VIRUS

K.E. WOLF, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Kearneysville, West Virginia* 25430

Situation: Egtved virus, a common but poorly characterized virus, is the cause of the most serious disease of propagated rainbow trout in Europe. Thus far Egtved virus is not known in North America. The U.S. annually imports tons of frozen European trout for table use. Such fish may be capable of harboring Egtved virus and of introducing the pathogen into North America.

Objective: The purpose of this work unit is to determine whether or not Egtved virus in fresh trout carcasses can survive the handling, freezing, and storage procedures of normal commercial table trout processing. If so, it is proposed to determine how long such virus can remain infective. Additional characteristic of the virus will be ascertained.

Procedure: In order to prevent accidental introduction of the virus, fish will not be infected, instead table size rainbow trout will be anesthetized in the laboratory then perfused with virus, killed, in part eviscerated -- in part left intact, then frozen. At regular intervals, the frozen fish will be examined virologically. The balance of the work will be performed with standard virological procedures.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0105, POSSIBLE BIRD TRANSMISSION OF 'MYXOSOMA CEREBRALIS'

R.E. PUTZ, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Leetown, West Virginia*

Situation: It is possible that fish-eating birds could feed on infected fish at one establishment and fly to one which is free of the disease. Spores can be shed in the feces but it is not known if they are viable.

Objective: To determine if spores passed in the feces of fish-eating birds are viable.

Procedure: Mr. Udell Meyers, Castalia Farms, Castalia, Ohio will feed infected fish to captive great blue herons. He will collect the feces and send it to Leetown. We will put the sporebearing feces in aquaria, allow it to 'age' 4 months and add rainbow trout fry to see if they will become infected.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0106, MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE

G.F. HARTMAN, State Dept. of Nat. Resources, *Madison, Wisconsin* 53701

Objectives: 1. To determine seasonal cycles in mucous cell function in Lake Michigan population of alewives and smelt as related to ancestoral patterns of anadromous migration. 2. Determine effects of thermal stress upon mucous cell function. 3. Determine relationships between changes in the protective mucous coat and osmoregulatory failure (or pathogenic infections) as a cause of mass mortalities in the alewife.

Justification: Mass mortalities of alewives cause serious and complex biological and economic problems in Lake Michigan. Knowledge of the cause of the dieoffs will be of great value to reesource managers and public health officials in predicting problems, and to plan their solutions. The alewife dieoffs are thought to correspond to periods of low mucous secretions. Knowledge gained will be of value to aid in the solution of fish disease epidemics and possibly in determining tolerable levels of pollutants.

Procedures: Study of external mucous cell numbers and of plasma and muscle electrolite levels will be followed seasonally. Effects of temperatures will be studied in the laboratory as will also be photoperiodism and salinity. Blood samples will be taken and studied for sodium, potassium and calcium concentrates.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0107, DIAGNOSIS OF DISEASES IN FISH

D.L. MITCHUM, State Game & Fish Commission, *Cheyenne, Wyoming* 82001

Objective: To diagnose, describe and inventory diseases occurring in the fish and wildlife of Wyoming and recommend control measures where possible.

Procedures: Diseased fish or portions of diseased specimens, submitted by field personnel, will be examined using standard methods of veterinary or human medicine to diagnose the condition. Field collections will be made from wild populations where necessary, and routine visits will be made to all State fish culture stations to observe and examine cultured stocks for diseases. Waters suspected of being unsatisfactorily for fish will be chemically analyzed, using standard methods.

Clinical signs of disease and pathological conditions will be described as observed in each case, and a report of findings will be submitted with recommendations for treatment or control to the person submitting material, making the request, or to the particular fish culture station.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3B. TREATMENT OR CONTROL MEASURES

(Emphasis May Still Be on Epidemiology)

3.0108, PARASITES OF WARMWATER FISHES AND THEIR CONTROL

R. ALLISON, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830 (ALA00194)

OBJECTIVE: Determine species, abundance and distribution of protozoan, helminth and arthropod parasites affecting warm water fishes. Determine immune response and effect of immunity in prevention of epizootics of parasites; develop chemotherapeutic and immunological methods for controlling fish parasites.

APPROACH: Parasitic species collected. Variations in abundance and geographic distribution recorded. Parasitic-free fish populations subjected to parasitic infections, cured by chemotherapeutic means and challenged with increased numbers of test species to test immunity. Efficacy of chemotherapeutic agents for fish parasite control determined.

PROGRESS: Fish populations containing immunized individuals were less susceptible than nonimmune populations to fixed infection levels of Ichthyophthirius. Populations stocked with 0, 25, 50 and 75 percent immunized fish had average survival rates of 0, 45.0, 87.5 and 100 percent respectively when infected at the rate of 10 trophozoites per fish. Previous research indicated all immune populations survive with no mortality at rates up to five times the initial rate. Cultures of Scyphidia and Trichophyra were maintained for brief periods under laboratory conditions. Scyphidia were maintained for 7 days in pond water enriched with yeast at 45 F. Cultures of Ichthyophthirius were maintained on live fish populations through out the year. Trophozoites recovered from hosts treated with 0.1 ppm Malachite green sporulate abnormally. After 72 hours exposure to this chemical no viable tomites were obtained. Toxicity levels of Bayer 9015, Co-ral, Ruelene, Baygon Tiguvon and Malachite green were determined for channel catfish fingerlings. The effect of Co-ral, Ruelene and Korlan, as a bath, stomach injection and interperitoneal injection, on infection with Ichthyophthirius was determined.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

3.0109, CONTROL OF MYXOSPORIDIAN PARASITES

W.A. ROGERS, Auburn University, Agricultural Experiment Sta., *Auburn, Alabama* 36830

Objectives: 1. To test and evaluate several food additive compounds for the control of Henneguya (myxosporidia) in channel catfish.

Procedures: 1. Several compounds that have proven effective against coccidial infections of poultry and cattle will be fed to naturally and experimentally infected channel catfish. 2. Effective dose levels of promising compounds will be determined.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0110, SPAWNING AND REARING OF MARINE FISH

P. HELFRICH, Univ. of Hawaii, Hawaii Inst. of Marine Biology, *Kaneohe, Hawaii* 96744

The temporal distribution of fish eggs in Kaneohe Bay is being determined from weekly plankton tows. Eggs from these tows are brought to the laboratory for rearing experiments. Presently, two marine species ('Caranx mate,' Gnathanodon speciosus') can be reared through metamorphosis in the laboratory with survival from 50 to 75%. The ecological factors influencing laboratory survival and growth of these species have been delineated. A detailed study of the artificial fertilization, growth rate and efficiency of energy utilization of 'C. mate' (omaka) larvae is nearly complete. The larvae of the fresh water baitfish 'Dorosoma petenense' (threadfin shad) has also been reared through metamorphosis in the laboratory and the effect of salinity on hatching and survival determined. Additional laboratory research on the laboratory ecology, growth and energy utilization of larvae of 'G. speciosus' (papio), 'Abudefduf abdominalis' (Maomao), 'Stolephorus purpureus' (nehu) and 'D. petenense' (threadfin shad) is underway.

The growth rate of juvenile 'C. mate' to marketable size has been ascertained (14 months),as well as their feeding efficiency. Hormone injection experiments are being conducted on this species to obtain reproduction and spawning in the laboratory. The growth rate, feeding and reproduction in captivity are being studied for the following fish also: 'G.speciosus' (papio), 'Parupeneus porphyreus' (kumu), 'Polydactylus sexfilis' (mio) and 'Seriola quinquiradiata' (Japanese yellowtail).

Considerable success in the identification and treatment of bacterial diseases affecting both larval and adult fishes has been achieved.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0111, INVESTIGATION OF HANDLING TECHNIQUES

J.S. HUGHES, State Wildlife & Fish Comm., *Baton Rouge, Louisiana* 70804

Objectives: (1) To determine handling techniques for various sizes of striped bass. (2) To investigate the use of anesthetics and therapeutic agents while moving striped bass.

Procedures: Striped bass fry will be reared in holding troughs until they are at least one week old. They will then be placed in rearing ponds for further growth. The bass will be seined from these ponds when they reach different inch groups for bioassay studies. Different types of seining and dipping methods will be used and conditions of the fish after handling will be noted. Handling methods evaluated will include: (1) the use of MS-222 or electricity in the seine while the fish are still in the pond; (2) treating the pond with formaldehyde or salt before seining; (3) the use of different mesh sizes of seines with knotted or knotless twine; (4) investigations of dip netting techniques; and (5) the use of antibiotics and anesthetics in the hauling container. Water quality records will be maintained and their effects on handling success will be noted.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0112, TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS

J.S. HUGHES, State Wildlife & Fish Comm., *Baton Rouge, Louisiana* 70804

Objectives; (1) To determine the toxicity of anesthetics and therapeutic agents to various sizes of striped bass.

Procedures: The procedures will follow those outlined in Job V. Bioassays will be conducted on but not be limited to the following: MS 222, quinaldine, malachite green, formaldehyde, acriflavine, and potassium permanganate. Fish will be observed for at least 96 hours and the concentrations where total mortality, total survival, and fifty percent survival occur will be reported for each 24 hour period. If parasites are present on striped bass in hatchery pond, thereapeutic agents will be applied to the pond and the results noted.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0113, PATHOLOGY - EPIZOOTIOLOGY

C.A. FARLEY, U.S. Dept. of Commerce, Natl Marine Fisheries Service, *Oxford, Maryland*

The pathological, parasitological, epizootiological, and cytochemical relationships of diseases in oysters are being studied. Receiving greatest attention with regard to the above is the haplosporidan, Minchinia nelsoni, an oyster parasite associated with massive oyster mortalities in Delaware and Chesapeake Bays. With the repeated discovery of definitive life cycle stages, its life history within the oyster has now been proposed. A system for determining stages of infection has been developed and is being utilized for interpretation of epizootiological data. Comparative studies are being made of epizootiological patterns in four populations of oysters in Pocomoke Sound, Maryland. Methods are being developed for determining DNA-RNA patterns in hosts and parasites and is receiving intensive study. Studies are also being made of causes of mortality in oysters from the west coast of the United States, British Columbia, and France and are being compared with local mortality causes.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0114, DISEASE-RESISTANT OYSTERS

H.H. HASKIN, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00783)

OBJECTIVE: Verify the relative high resistance of Delaware Bay oyster stocks to MSX, increase the supply of such oysters, study and modify current procedures for artificial rearing of oysters, experimentally transmit MSX in the laboratory and increase the yield of market oysters by the control of predators.

APPROACH: Field experiments will be established to accomplish most of the objectives. Disease free oysters will be impored and planted where necessary, various chemicals will be tested for the control of shell-fouling and oyster drills. Laboratory procedures will be established to study artificial rearing of oyster and to experimentally transmit MSX under controlled conditions so that the nature of this disease will be more fully known.

PROGRESS: Production of disease-resistant oysters in Delaware Bay has been continued on several fronts. Eight additional parent stocks, 4 resistant and 4 susceptible, have been used in lab-rearing studies to produce progeny for testing of resistance to 'MSX' (Minchinia nelsoni). One pair of these stocks (Sheepscot River, Maine, parents - susceptible; and Old Delaware Bay Tray Stock parents - resistant) are under intensive study in a controlled exposure experiment. First year mortalities in similar stocks of the 1967 year class have shown spectacular differences. For example, in two resistant stocks of the 1967 rearings the 'MSX' kill from March through August, 1968, was 23 and 25%; in two susceptible stocks in the same period kills were 74 and 75%. Such studies have firmly established existence of heritable qualities of disease resistance in oyster stocks. The additional controlled exposure studies now underway are our first attempts to determine if oysters may show increased resistance after an initial light exposure (acquired immunity). Field studies, establishing levels of 'MSX' in various stocks of oysters throughout the Bay, have also been continued with monthly sampling. Of 7 plants ground which were sampled in November, 1968, 'MSX'-infection levels in 6 ranged from 50 to 75%. The standout, at 15%, was an experimental planting of native lower Bay set on the Laboratory ground. This indicates that, within the Bay, there are still distinct differences in 'MSX'-resistance in various groups of oysters.

SUPPORTED BY New Jersey State Government - Trenton

3.0115, REPRODUCTION & FUNGAL PARASITES AFFECTING REPRODUCTION IN LOBSTER, HUMARUS AMERICANNA, & BLUE CRAB CALLINECTES SAPIDUS, IN N.C. WATERS

E.P. RYAN, East Carolina University, School of Arts, *Greenville, North Carolina* 27834

The proposed research includes a study of reproductive cycles and diseases affecting reproduction in the blue crab,' Callinectes sapidus' Rathbun, and the New England lobster,'-Homarus americanus' Milne-Edwards. Breeding season for the lobster population will be determined by histological examination of individuals periodically sampled from the population coupled with periodic plankton sampling of the population areas in North Carolina waters. Tagged female blue crabs will be reared during phases of their reproductive cycles. These crabs will then provide histological material for studies of cyclic changes of the reproductive system.

Recent fluctuations in the quantity of blue crabs caught in commercial fishing indicate the possibility of disease affecting crab reproduction. Because of the frequency with which a fungal parasite, 'Lagenidium callinectes', has been reported on eggs of the blue crab (Couch, 1942; Rogers-Talbert, 1948; Scott, 1962), a detailed study of the effect of fungal parasites on the reproduction of the blue crab and other commercially used crustaceans is in order.

The primary objective of the proposed study of fungal parasites is to determine the significance of such parasites on the relative abundance of blue crabs and to determine how such parasites can be controlled or eliminated if necessary. Methods of study will include detailed field studies of crabs during their reproductive season with subsequent laboratory studies of the fungi in relation to the crabs.

SUPPORTED BY University of North Carolina

3.0116, RELATIONSHIP OF TEMPERATURE TO DISEASES OF SALMONID FISH

J.L. FRYER, Oregon State University, Graduate School, *Corvallis, Oregon* 97331

This project will have as its chief objective the determination of the effect of water temperature upon the more important infectious diseases of the salmonid fish native to the Columbia River system. These will include the protozoal infection caused by Ceratomyxa shasta, the bacterial infections due to Chondrococcus columnaris, Aeromonas liquefaciens, Aeromonas salmonicida, and the virus disease of sockeye salmon. The work will be done in a research facility where an adequate range of water temperatures can be provided in experimental tanks. Infections will be produced by inoculation of the test animals with a pure culture of the pathogen being studied by the most appropriate route. The course and extent of disease will be measured by the incidence of fatal infections during the experimental period, and perhaps by other criteria if found practical. The effect of temperature on the survival of the various pathogens in vitro in river water will be determined. The possibility of arresting established infections by changing water temperature will also be explored.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

3.0117, CONTROL OF VIBRIOSIS IN SALMON

J.L. FRYER, Oregon State University, Agricultural Experiment Sta., *Corvallis, Oregon* 97331 (ORE00910)

OBJECTIVE: Determine the number of serological types of pathogenic marine vibriosis occurring in salt water areas on the Oregon Coast. Develop an oral vaccine which will afford disease protection for salmonid fish reared in these areas. Determine the effectiveness of Furanace (P 138) for control of pathogenic marine vibrios of salmon.

APPROACH: Serological Types: cultures of pathogenic marine vibriosis will be collected and injected into rabbits for the production of an immunizing serum. Serum against these various isolates will then be used to determine the number of serological types of pathogens present in the environment. Vaccination: various types of vaccines against vibriosis will be developed and tested by injection and incorporation into the diet for oral administration. Furanace (P138): this drug will be incorporated in the ration and in the water to determine the effectiveness for control of this disease. Various levels will be used to determine the optimum concentration.

PROGRESS: A vaccine has been prepared against Vibrio anguillarium and administered to salmon by means of the oral route. The results of five experiments currently indicate that as the vaccine is administered so that each animal receives 300 micrograms during a 14-day period, the loss can be reduced from approximately 95% to approximately 15%. The use of booster feedings administered after the initial vaccination period does not appear to enhance the immunization process. It appears necessary that water temperatures during immunization must be above 50 F.

SUPPORTED BY Oregon State Government - Salem

3.0118, AQUICULTURE, OYSTER HATCHERIES - RESEARCH

W.J. MCNEIL, Oregon State University, School of Agriculture, *Corvallis, Oregon* 97331

Seed from the pilot oyster hatchery will be distributed to growers on a 12-month basis. Growers will be given an opportunity to receive on- the-job training in hatchery operations. Studies on heritability and selective breeding of oysters will be continued, and increased emphasis will be placed on cryopreservation of oyster gametes and osmotic regulation in oysters. Use of pesticides to control pests on oyster grounds will be tested. Use of heated sea water from the steam-electric stations to grow oysters will be studied.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

3.0119, EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS

H.J. RAYNER, Oregon State University, State Game Commission, *Corvallis, Oregon* 97331

1. To determine the feasibility of rearing salmon and steelhead fry to smolts in brackish water impoundments. 2. To determine optimal stocking intensitics, survival rates, mortality cause, and environmetal control procedures that produce the largest return of adult fish.

Progress: Fall chinook fry, coho fry and steelhead fingerlings are introduced into the pond which is usually filled with fresh water. As the salinity tolerance of the fish increases, seawater from Alsea Bay is added. The growth rate of the fish at various stocking densities is closely watched. Differential marking and adjustment of the point of release is being used to test the homing imprint of saltwater-reared smolts. The size of fish released and the location of release will be tested at the time of return of marked adults.

Supplemental feeding of spring, fall chinook, coho and winter steelhead in brackish water is being evaluated. Sulmet, terramycin(TM- 50), furance (P-1738), and vaccines are being tested in an effort to control the saltwater fish disease in Vibrio anquillarum Type C.

SUPPORTED BY Oregon State Government - Salem

3.0120, EVALUATION OF STRESS IN FINGERLING SALMON THERAPEUTIC DRUGS AS STRESS FACTORS

J.L. BANKS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Longview, Washington* 98632

Objective: To develop reliable methods for measuring the effects of stress from therapeutic drug treatments.

Procedure: Two types of drugs, those used for internal medication and those applied externally, will be studied. Groups of non-diseased fish will be treated with therapeutic drugs at concentrations and exposure periods similar to those commonly used in hatcheries. Differences between pre-treatment and post-treatment measurements of glycogen reserves, blood cell counts and sizing, hematocrits, plasma proteins, and other blood components should indicate which tests, if any, are reliable for measuring the affects of stress from drugs.

Work Schedule: Detailed information will begin in May, 1967. Those hematological and chemical tests which will measure stress from therapeutic drugs should be determined by the summer of 1969.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0121, IN VIVO CHEMOTHERAPEUTIC STUDIES ON FISH PATHOGENIC BACTERIA

D.F. AMEND, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle, Washington* 98115

Fish infected by natural or artificial methods with virulent bacteria will be treated with chemotherapeutic agents which show promise of practical usage from previous in vitro and toxicity studies.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0122, ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - FURUNCULOSIS IN COHO SALMON

A.J. ROSS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle, Washington* 98115

Furunculosis in juvenile coho salmon (Oncorhynchus kisutch) has been a problem for years in Federal and State hatcheries in the Pacific Northwest. This study is designed to make an antigenic preparation of the etiologic agent, Aeromonas salmoncida, and to feed it in the regular diet to fingerling coho salmon - first in the laboratory and then in the production hatchery.

The rate and route of uptake of the antigen as well as its effective dosage, immunogenic properties, toxicity, and retention time in fish will be determined using various immunological methods. Following this, USDA and FDA clearance will be applied for prior to its release for general use in production hatcheries.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0123, CHEMOTHERAPEUTIC STUDIES ON FISH PATHOGENIC BACTERIA

A.J. ROSS, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle, Washington* 98115

In order to control many bacterial epizootics in hatcheries it often becomes necessary to treat with antibiotics or drugs. As new compounds are being produced frequently,it is desirable to screen them in an effort to select those which may be more efficacious than those in current use.

Standard techniques will be used to test compounds in vitro. Those showing promise will be tested in vivo.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0124, BIOCHEMICAL CHANGES IN FISH DISEASES - THE STRESS OF FORMALIN TREATMENTS IN SALMONID FISHES

G. WEDEMEYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle, Washington* 98115

Formalin is a very useful chemical for controlling the external parasites of hatchery reared fish. Mortalities sometimes result from its use.

In previous work with a resistant (coho salmon) and a susceptible (rainbow trout) salmonid, the physiological and biochemical changes during formalin treatments which result in death or survival were investigated.

These findings, centering around blood gas and acid-base balance, will be extended to two more salmonids - the eastern brook trout and the steelhead trout.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0125, EFFICACY OF A POTENTIATED SULFONAMIDE AGAINST FURUNCULOSIS INFECTIONS IN JUVENILE RAINBOW TROUT AND COHO SALMON

G. WEDEMEYER, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Seattle, Washington* 98115

Sulfa drugs containing folic acid inhibitors have proven effective against turkey coccidiosis, fowl cholera and infectious coryza. A new potentiated sulfonamide, RO 5-0013, will be tested for efficacy against 'Aeromonas salmonicida' (furunculosis) infections of juvenile rainbow trout and coho salmon. The work will be done in co-operation with Hoffmann-La Roche who are furnishing the experimental drug.

Toxicity of this compound will be evaluated using standard clinical chemistry tests of liver, kidney and gill function.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0126, AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS

E.J. ORDAL, Univ. of Washington, School of Medicine, *Seattle, Washington* 98105 (AT(45-1)2225.010)

The objectives are the investigation of bacteria pathogenic to fishes and on the effects of water temperature on diseases of salmon and trout due to these bacteria. The impact of columnaris disease is markedly increased by higher water temperatures but whether mutations to increased virulence occur needs to be determined. The effect of water temperature on myxobacteria isolated from salmon suffering from Ulcerative Dermal Necrosis, as well as on certain other myxobacteria isolated from fish at low water temperatures, will be investigated.

Major emphasis will be given to the investigation of marine vibrios isolated from waters of the Pacific Northwest. These will be compared with a group of marine vibrios from Japan including strains causing human disease which resemble some strains found in the Pacific Northwest. Major effort will be given to the effect of water temperatures on vibrio infections in salmon and trout.

These will eventually be extended to study the effect of warm sea water in aquaculture.

SUPPORTED BY U.S. Atomic Energy Commission

3.0127, CHEMOTHERAPY OF FISH DISEASES

R.L. HERMAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Kearneysville, West Virginia* 25430

Object: Evaluate sulfisoxazole, sulfadimethoxine, and a potentiated compound of sulfadimethoxine (RO-5) for toxicity and efficacy.

Procedure: Artifically infect trout with fish pathogenic bacteria, susceptible to the drug and determine the effective dose. Feed multiple levels of the drugs to determine toxic side effects.

A cooperative project with Hoffman - LaRoche.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0128, PARASITES AND PARASITIC DISEASES OF FISHES - STUDY OF NEW METHODS FOR CONTROL OF ICHTHYOPHT

G.L. HOFFMAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Kearneysville, West Virginia* 25430

Objective: This is a modified continuation of Work Unit 8 and is re-activated under a new number because of the availability of new chemicals and the continued importance of Ich disease.

Procedure: New chemicals will be tested against the free-living stages of 'Ichthyophthirius'.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0129, CONTROL OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA FILTRATION AND ULTRAVIOLET IRRADIATION

G.L. HOFFMAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Kearneysville, West Virginia* 25430

Situation: Better means of control of whirling disease (Myxosoma cerebralis) are needed.

Objective: To test ultraviolet irradiation and chemical disinfectants for the control of whirling disease (WD).

Procedure: I. It has been shown that water from tanks containing soil, and contaminated with spores of M. cerebralis, is capable of transmitting this parasite to healthy trout. Therefore the decontaminating effect of measured exposure of such water to U.V. radiation will be determined. Dosage of 112,500 microwatts/sec/cm2 (MWS) has been found effective; 40,000 MWS, perhaps less, will be tried soon. II. Tanks containing infective material in a manner simulating conditions existing in contaminated ponds will be treated by selected chemicals in order to determine at first qualitatively, and later quantitatively, their disinfecting effectiveness. III. Test fish will be placed in as many selected locations as possible to attempt to determine the source of the WD contamination. If possible, contaminated water at the Lahontan NFH, Gardnersville, Nevada, will be treated with 30,000, 60,000, and 90,000 MWS U.V. light to determine the minimum lethal dosage.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0130, EFFECT OF DISINFECTING AGENTS ON M. CEREBRALIS

G.L. HOFFMAN, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Leetown, West Virginia*

Situation: There is great need for better disinfection methods for whirling disease.

Objective: To find better disinfecting methods.

Procedure: Simulated pond aquaria will be seeded with spores of Myxosoma cerebralis. After aging 4 months, the 'ponds' will be treated with test disinfectants. After treatment, test fish will be placed in the aquaria to see if the spores have been killed.

Preliminary work will include exposing the spores to various chemicals and observing them microscopically for visible damage.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0131, TRANSMISSION OF MICROSPORIDA

R.E. PUTZ, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Leetown, West Virginia*

Situation: Transmission of fish Microsporida has never been demonstrated. Microsporida have been involved in fish epizootics under natural and hatchery conditions.

Objective: To demonstrate transmission of fish Microsporida so that experiments on prevention and control can be conducted on a rational basis.

Procedure: To take viable spores of fish Microsporida, treat them by physical and biological means, and inject them into susceptible fish.

Take viable spores of fish Microsporida and seed aquaria to simulate natural conditions under which transmission takes place.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0132, TRANSMISSION OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA

R.E. PUTZ, U.S. Dept. of the Interior, Bur. of Sport Fish. & Wildlife, *Leetown, West Virginia*

Situation: The transmission of Myxosoma cerebralis, or any other fish Myxosporida has not been experimentally demonstrated.

Objective: To elucidate the life cycle of M. cerebralis and other fish Myxosporida which attack cartilage. This will open a rational approach to the development of control methods.

Procedure: I. Determine the invertebrate fauna of Myxosoma contaminated aquaria. Take these invertebrates and place in an aquaria with susceptible fish. Transfer fomites from Myxosoma contaminated aquaria to aquaria with susceptible fish. II. Use various porosity membrane filters to determine size range of the infective units other than spores. III. Set up aquaria with soil, running spring water and seed with Myxosoma spores to simulate natural conditions of transmission.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0133, THE TOXICITY AND DRUG RESIDUE LEVEL OF CHLORAMPHENICOL IN TREATED RAINBOW TROUT

D.L. MITCHUM, State Game & Fish Commission, *Cheyenne, Wyoming* 82001

Objective: Determine the toxicity of Chloramphenicol (Chloromycetin) to rainbow, cutthroat, brook and brown trout, and determine the residue level and residual period of this drug in the blood and tissues of these trout, in order to obtain U.S. Food and Drug Administration approval to use Chloramphenicol in control of fish diseases.

Procedures: Develop a suitable test to assay Chloramphenicol in fish tissues.

Determine the toxicity of Chloramphenicol to rainbow trout, and determine the residue level and residual period of this drug in the blood and tissues of rainbow trout, in order to obtain FDA approval to use Chloramphenicol in control of fish diseases.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

3.0134, DIAGNOSIS OF DISEASES IN WILDLIFE

E.T. THORNE, State Game & Fish Commission, *Cheyenne, Wyoming* 82001

Objective: To diagnose, describe and inventory diseases occurring in the fish and wildlife of Wyoming and recommend control measures where possible.

Procedures: Diseased wildlife or portions of diseased specimens, submitted by field personnel, will be examined using standard methods of veterinary or human medicine to diagnose the condition. Field collections will be made from wildlife populations where necessary.

Clinical signs of disease and pathological conditions will be described as observed in each case, and a report of findings will be submitted with recommendations for treatment or control to the person submitting the material or making the request.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

DESCRIPTION OF RESEARCH TASKS

4. AQUATIC PEST ECOSYSTEMS

(Phenology, Life History, Habitat, Distribution and Classification)

4A. AQUATIC ALGAE AND AQUATIC VASCULAR PLANTS

4.0001, INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT
D.E. DAVIS, Auburn University, School of Agriculture, *Auburn, Alabama* 36830

Five aquatic weed species, alligator weed (Alternanthera philoxerides (Mart.) Griseb), water hyacinth (Eichornia crassipes (Mart.) Solms), egeria (Egeria densa Planch), slender naiad (Najas flexilis (Willd) Rostk and Schmidt), and curly pondweed (Pontamogeton crispus L.) will be grown in 100% well water and in 75% well water and 25% sewage effluent. Experiments will be conducted in pools out-of- doors and in plastic pans in a growth chamber. The following determinations will be made: (1) effect of sewage effluent on the growth of the aquatic weeds and phytoplankton, (2) effect of the growth of aquatic weeds on the removal of nitrogen and phosphorus from the water and on the growth of phytoplankton, and (3) the amounts of protein, total nitrogen and phosphorous present in the different aquatic weed species grown in different sewage concentrations.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0002, RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY
K.V. SLACK, U.S. Dept. of the Interior, Geological Survey, *Menlo Park, California* 94025

Biological processes are among the major controls on the quality of natural waters. Organic control on solute concentration occurs in two ways: substances enter or leave solution either as the results of changed physico-chemical conditions in the water, or as the results of physiological processes within living cells or at their boundaries.

The work is divisible into three related phases:

Phase 1. Stream Limnology. a. The effect of stream-bed algae on water quality will be studied in flowing-water cultures (laboratory streams) in which temperature, light intensity, flow rate, water composition and algae species can be controlled. The first problem being studied is the uptake and release of combined inorganic nitrogen by mixed populations of stream algae. b. Investigation of the physical, chemical and biological properties of different types of natural streams will continue. The emphasis will be on the interrelations of the biota and water quality.

Phase 2. Lake and reservoir limnology. a. Effects of reservoir destratification. The hydrologic effects of destratification will be studied experimentally by isolating portions of a stratified reservoir in polyethylene cylinders extending from the water surface to the bottom. b. Environmental controls on phytoplankton populations. This will combine the results of field investigation with controlled laboratory studies of static and flowing cultures of nuisance species of algae.

Phase 3. Ecological role of natural organic compounds in water. The particular emphasis will be on the identification of organic compounds which influence biological activity in natural waters.

SUPPORTED BY U.S. Dept. of Interior - Geological Survey

4.0003, FIELD INVESTIGATION OF THE SUBMERSED AQUATIC ENVIRONMENT
N.E. OTTO, U.S. Dept. of the Interior, Bureau of Reclamation, *Denver, Colorado* 80225

Study of the ecological relationships of plants and animals in canal environments are necessary to gain understanding of biological problems existing in these areas. Knowledge of environmental factors and interactions are essential to future improvement of aquatic weed and animal problems existing in irrigation distribution systems. Data have been collected from irrigation canals in three different geographical areas concerning the physical, chemical, and general biological aspects. Samples of soil, water, and biological materials are being collected for chemical and physical analyses in both weed-free and heavily infested canal sites. Observations are being made of all physical, chemical, and biological factors suspected as being important in the environment. Data obtained to date indicate that rooted submersed aquatic weeds are adapted to a wide range of environmental conditions. Present emphasis on this phase of the aquatic pest investigations program is associated with more detailed study of the nutrient requirement of submersed aquatic weeds, including filamentous green algae and bluegreen algae. Preliminary results of nutrient studies suggest that carbon availability can be more restrictive to aquatic weed growth than inorganic element availability.

SUPPORTED BY U.S. Dept. of Interior - Bu. Reclamation

4.0004, THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER
M.S. SHANE, Univ. of Delaware, School of Arts, *Newark, Delaware* 19711

The ecology of LPP phyco-viruses will be studied in relationship to pollution in the Christina River. Samples of water from designated stations in the river will be examined for the presences of LPP phyco- viruses and also the host genera of algae. Water quality studies will be performed on the same samples used for biological studies. Parameters like biochemical oxygen demand, dissolved oxygen, total nitrogen of phosphorus, pH, alkalinity, and hardness will be determined.

An attempt will be made to study the mechanisms involved in population control of host algae in relationship to the virus.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0005, TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS
R.L. SHIRLEY, Univ. of Florida, Agricultural Experiment Sta., *Gainesville, Florida* 32601 (FLA-AL-01460)

OBJECTIVE: Determine the concentration of toxicants i.e. nitrate, cyanide, dicoumarins and oxalates, as well as nitrogen and mineral content of hyacinths and other water plants.

APPROACH: Hyacinths will be collected from water containing varying levels of nitrogen as reported by the U.S. Geol. Survey. They will be collected by approximately monthly intervals throughout the year. Bivans' Arm lake is relatively high and Santa Fe lake is low in nitrogen content among Florida lakes. It is planned the first year to obtain samples from Bivans' Arm, Sante Fe, and Apopka lakes and the Kissimmee and St. John's rivers. Degree of flowering, height above water line, pH, temperature and mineral content of water will be used as related factors to concentration of toxicants that occur in the plants. Young female mice will be fed diets containing 50% dry hyacinth and elodea through gestation and lactation periods to determine if toxicity problems exist.

PROGRESS: Hyacinths from three lakes in Florida (Santa Fe, Bivens Arm, Apopka) and two rivers (Kissimmee, St. Johns) were removed monthly starting in March 1969, and analyzed for a number of forage toxicants to livestock and for proximate analyses composition. Nitrate was highest during March with a range from 0.1 to 0.3%; April through June values were less than 0.1%. Cyanide was highest in March with values ranging from approx. 190 to 380 mg. per lb. dry weight; while corresponding values in April through October were about half this amount. Oxalate during March through June had values ranging in all samples from approximately 0.2 to 0.7% with a tendency to be lower in June. Dicoumarin ranged from approx. 10 to 45 mg. per lb. dry weight during March through August. In September higher values occurred in the range of 80 to 140 mg. per lb. dry weight except from the St. John's river which was the same as previously. Xanthophyll ranged from approx. 150 to 250 mg. per lb. in Apopka Lake during March, April and May; and corresponding values in the other two lakes and two rivers ranged from 40 to 115 mg. per lb. Carotene ranged from 30 to 35 mg. per lb. dry weight for Lake Apopka in March and May; and corresponding values for the other lakes and two rivers varied from approx. 8 to 21 mg.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

4.0006, RELATIVE LEACHING RATES OF COMMON NITROGEN CARRIERS FROM SANDY SOILS IN RELATION TO LAKE EUTROPHICATION

D.E. SMITH, Rollins College, Undergraduate School, *Winter Park, Florida* 32789

Objective: Field and laboratory studies will be aimed at determining the relative leaching rates of various nitrogen carriers from sandy soils surrounding the Winter Park, Florida chain of lakes. Its purpose is to evaluate the relationship of lawn fertilization to nitrogen enrichment of lakewater.

Approach: The project will have three aspects: (1) Analysis of storm drain effluent for total available nitrogen; (2) Laboratory determination of nitrogen losses from sterilized soil columns; (3) Tabulation of amounts, frequency of application and types of fertilizers used by lakefront and proximate landowners. Results of the investigation are expected to increase our understanding of the causes of acute weed problems in Central Florida lakes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0007, ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS

L.C. MARSHALL, Southern Illinois University, Graduate School, *Carbondale, Illinois* 62901

The purpose of this work is to investigate the formation of constituents that comprise the atmosphere of terrestrial planets such as Earth, Mars, and Venus. This is a continuation of work that began under the direction of Drs. Lloyd Berkner and Lauriston Marshall. The continuing research will include the following areas: (1) further study of 02 stability in the earth's atmosphere using an E2 Oxygen Analyzer and the differential photometric technique; (2) measurements of atmospheric constituents using remote sensing methods such as lasers; (3) studies of the effect of oxygen deprivation on several pure strains of blue-green algae; (4) the effect of pollutants and pesticides on blue-green algae and other oxygen producing organisms; (5) the effect of high magnetic fields on blue-green algae and the chemicals that are important to their composition and functions; (6) studies of crystalline materials and molecular structures of biological systems at the molecular level; and (7) studies of the mechanisms of cyclic and noncyclic photosynthetic photophosphorylation.

SUPPORTED BY U.S. National Science Foundation

4.0008, EUTROPHICATION OF IOWA LAKES AND STREAMS

R.W. BACHMANN, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01779)

OBJECTIVE: Determine the critical nutrients responsible for eutrophication in Iowa waters.

APPROACH: Carbon-14 algal bioassays will be run on selected natural waters to determine which nutrients are critical to algal production. Quantitative chemical studies will be made of these critical elements to determine their sources and cycles within the water body in question. A search will be made for means to disrupt the cycles of critical elements.

PROGRESS: Major efforts have been expended in setting up the laboratory facilities to carry out the carbon-14 nutrient bioassays. A constant temperature, illuminated incubator has been constructed with provision for magnetic stirring of the experimental cultures. Bioassays of water samples from the Des Moines River will begin during the coming year. A sampling program was initiated on 17 streams and 7 lakes in the central Iowa region. Analyses are being made of plant nutrients and algal populations for the purpose of providing baseline information of the state of eutrophication of these waters.

SUPPORTED BY Iowa State Government - Des Moines

4.0009, OCCURRENCE OF FILAMENTOUS SLIMES ORGANISMS BELOW OUTFALLS

J.D. PHAUP, State Water Pollution Control, *Frankfort, Kentucky*

Description: The primary objective of this research is to study the occurrence of filamentous slime organisms in streams and to determine the mechanisms responsible for such occurrences. While special emphasis will be placed on nuisance growths of the filamentous bacterium, Sphaerotilus natans, all filamentous growth below outfalls will be investigated, including algal blooms. The amount and character of slime growth will be determined and the type of discharge stimulating such growth will be characterized. Chemical and physical characteristics of effluents and receiving streams will be defined in an effort to determine why these organisms appear in bloom proportions in some streams and not in other similar streams. The floc community will be identified and compared to previously noted associations.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

4.0010, LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES

J.B. BAKER, Louisiana State University, Agricultural Experiment Sta., *Baton Rouge, Louisiana* 70803 (LAB01089)

OBJECTIVE: Study the life cycles of the two grasses mentioned with special attention to dormancy, germination, growth, seed production and longevity, and production of vegetative reproductive structures. Develop culture or chemical means of control and to correlate the information obtained from objective 1 with response to these cultural or chemical control measures.

APPROACH: Samples of seed, vegetative reproductive structures, and entire plans will be collected. Plants will be established in the greenhouse for observation and study. Dormancy, longevity and germination studies will be conducted in the laboratory and greenhouse. Greenhouse preliminary studies on the response of these grasses to herbicides will be conducted.

PROGRESS: Further research into the germination characteristics of the aquatic weed, Heteranthera limosa, has determined that the seed requires light and anaerobic conditions for germination. Treatment with cold does not affect germination but cold storage prolongs high germination percentages. The light requirement is a red/far red response and is not photoperiodic. The anaerobic requirement is specific for the removal of O(2) from the environment. Flushing with N(2), H(2), Ne, Ar, or CO(2) will facilitate germination. On oxygen tension above 1% or 7.6 mm Hg completely inhibits germination. The process of germination centers in the breakdown of intercellular material of certain cells in the seed coat and the elongation of the chalozal end of the embryo to force open the weakened seed coat wall. The elongation of the embryo is facilitated by the absorption of water by protein aleurone grains and the release of osmotically active material from the dissolving grains.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

4.0011, AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES

M.W. HALL, Univ. of Maine, School of Technology, *Orono, Maine* 04473

This study provides field and laboratory data relative to several parameters thought to be important in the control of lake aging, soils, nitrogen and phosphorus concentration, alkalinity, temperature, pH, water clarity, lake morphology, etc.

The field data obtained is being used to determine: (1) The nutrient levels responsible for nuisance algal conditions in selected Maine lakes. (2) The effect of other selected parameters on critical nutrient levels. (3) The rate of change in nutrient levels in several Maine lakes, and the causes of this change. (4) The effects of the removal of major sources of nutrients on algal conditions in the lakes' waters. (5) The effect on the progress of algal development caused by biological treatment of wastewaters which eventually enter lakes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0012, BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY

J.H. MANNING, State Dept. of Ches. Bay Afrs., *Annapolis, Maryland* 21404

Objectives: (1) To determine the abundance and distribution of Eurasian milfoil and other rooted aquatic plants in Middle River, Back River, Rhode River and adjacent creeks in Chesapeake Bay; (2) To analyse environmental conditions in these rivers, and to study factors now excluding milfoil from Back River; (3) To begin the study of milfoil disease and pathology.

Procedures: Distribution and abundance surveys will be done at regular intervals throughout the year; environmental analyses will involve routine measurements of temperature, salinity, pH, light penetration, plankton conditions, nutrient supplies, and trace elements, and other relevant parameters; studies of milfoil pathology will involve histology, pathogen culture, and laboratory transmission studies.

SUPPORTED BY U.S. Dept. of Commerce - N.O.A.A.

4.0013, ANATOMICAL, PHYSIOLOGICAL AND ECOLOGICAL STUDIES ON MYRIOPHYLLUM SPICATIU

R.D. RAPPLEYE, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (MD-F-019)

OBJECTIVE: Study the gross morphology, anatomy and mineral composition under different salinities and determine seasonal changes, determine the photoperiodic requirement for the induction of flowering and the modifying influence of salinity thereon, determine the growth rate under various light intensities, salinities, and temperature. Study its mode of asexual reproduction. Determine the extent to which the species has invaded freshwater ponds and water impoundments of the state.

APPROACH: Periodic collections at intervals of two to four weeks will be made over a period of one year, the material either sectioned or analyzed chemically for major elements. Studies will be carried out in the laboratory under various light, temperature and conditions of known salinity in growth chambers. Will be concerned primarily with how small a piece of stem is required for regeneration, whether a node must be present or not and how much wave action is required to break up the plant using wage tanks of Army Engineers.

PROGRESS: The final phase of this project, an anatomical description of the plant and how it is altered by saline waters has been completed.

SUPPORTED BY Maryland State Government

4.0014, THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS

R.M. DEVLIN, Univ. of Massachusetts, Agricultural Experiment Sta., *Amherst, Massachusetts* 01002 (MAS00266)

OBJECTIVE: Study the growth and development of Myriophyllum, Potamogeton, and Elodea in axenic or algae-free cultures. Relate the results obtained to the distribution, management and control of the genera.

APPROACH: Chemical variables (solids, pH and dissolved gases), physical variables (light and temperature), and biological variables (competition and stimulation) will be determined, measured and evaluated.

PROGRESS: Growth of the aquatic weed Potamogeton nodosus in complete and various mineral-deficient media under continuous light (800-foot candles) and constant pH (6.0) conditions was observed. Temperature was also kept constant (22 1 C) and all plants were subjected to a photoperiodic cycle of 16 hours light and 8 hours dark. Algal growth was controlled with periodic additions of 1 ppm CuSO(4) to the growth medium. Growth in the absence of Ca coupled with absence of either P, Mg, or S was observed. In all cases Ca deficiency symptoms were so obvious, and appeared so soon, that influences caused by the absence of P, Mg, or S could not be observed. For the first five days P. nodosus, growing in the absence of the above-mentioned combinations of elements, appeared quite normal. On the sixth day black dots appeared on the leaves of plants growing in the absence of both Ca and P, and by the seventh day the leaves of all plants lacking Ca possessed these necrotic spots. By the eighth day necrotic areas had enlarged considerably and also appeared quite noticeably on the stems, plants lacking both Ca and P being most obvious in this respect. Ten days after being placed in the various growth media all plants with the exception of the controls were completely black or dark brown in color and apparently dead. It appears from this study and last year's study with Myriophllum spicatum that Ca is a very important element in the growth of aquatic weeds--perhaps as important as N.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

4.0015, NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA

W.C. LARSON, Detroit Lakes Engin. Dept., *Detroit Lakes, Minnesota*

Disposal of nutrients from municipal, private, domestic, and agricultural wastes in the Detroit Lakes, Minnesota area poses a serious problem owing to the high groundwater table, very permeable gravel aquifer, and wide interception routes of groundwater underflow. Several lakes in the chain of lakes in this area very important to the recreational needs of the community and valuable to the tourist industry have experienced catastrophic aquatic weed and algal growths in recent years as a result of nutrient enrichment. These lakes are interconnected by the Pelican River or its tributaries and are situated down gradient (to the southwest of Detroit Lakes, Minnesota). Since sources of nutrients are widely scattered it would not be economically feasible to intercept all waste outfalls with a central distribution system and provide subsequent treatment. It is proposed that nutrients in this sewage disposal system be intercepted or diminished in two different ways: 1) by dispersing the effluent from secondary treatment facilities on peat land and 2) by harvesting aquatic vegetation which contains nutrients. It is intended that by manipulation of natural environmental processes the rate of eutrophication will be arrested at minimal expense.

SUPPORTED BY U.S. Dept. of Interior - F. Wtr. Qua. Adm.

4.0016, PHYTOPLANKTON NUTRITION AND PHOTOSYNTHESIS IN EUTROPHIC LAKES

R.O. MEGARD, Univ. of Minnesota, School of Biological Sciences, *Minneapolis, Minnesota* 55455

4. AQUATIC PEST ECOSYSTEMS

The objective of this project is to analyse the nutritional requirements and the photosynthetic system of the phytoplankton in four Minnesota Lakes that receive nutrients from different sources and produce dense populations of nuisance algae. Algal nutrition, photosynthesis, and population densities will be studied before and after the nutrient influx to one lake is reduced, whereas nutrient- abatement programs for the others are either being discussed or they are in various stages of implementation. Analyses of algal nutrition, photosynthesis, and population densities that were begun during a regional limnological survey will be continued, but the emphasis will be somewhat different at each lake.

The research will monitor the effects of stopping the flow of sewage in the productivity of Lake Minnetonka. Advanced sewage treatment as a lake-management procedure and its effectiveness compared to sewage diversion will be evaluated in Shagawa Lake studies. The effectiveness of diverting sewage effluent from Sallie Lake and using the effluent for spray irrigation will be appraised. The results of the research project should assist the State in solving its lake pollution problems.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0017, LAKE SUPERIOR PERIPHYTON IN RELATION TO WATER QUALITY

T.A. OLSON, Univ. of Minnesota, School of Public Health, *Minneapolis, Minnesota* 55455

Description: The overall objective of the study has been to evaluate the nature and extent of periphyton growth in Lake Superior. Although the study has been aimed primarily at the delineation of a base-line which can be used as a reference in future years to measure any tendency toward eutrophication, other basic aspects have been studied. (a) The extent of the periphyton growth in selected areas of Lake Superior. (b) The make-up of the periphyton mass in terms of its plant and animal components. (c) The possible interrelationships existing between the periphyton and plankton. (d) The productivity potential of the periphyton in relation to the typical productivity of water in the open lake. (e) The importance of changing seasons on the characteristics of the periphyton. (f) The principal chages which will take place in the periphyton when polluting materials are introduced into the lake. (g) The speed and the phases of growth demonstrated by periphyton in reestablishing itself on an artificially denuded area. Of these, all have been accomplished except (c) and (f). Therefore, for the continuation period the study will be directed toward these two objectives.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

4.0018, A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE

A.C. MATHIESON, Univ. of New Hampshire, Graduate School, *Durham, New Hampshire* 03824

In the present investigation the species composition, periodicity and abundance of algal populations from three areas (Newfound Lake, Winnisquam Lake and New Hampton Stabilization Pond and Lake Winnepesaukee differing with respect to water quality, will be compared in order to assist in the prediction, prevention, and control of algal blooms in New Hampshire water supplies. These three areas show a marked difference with respect to pollution, i.e., Newfound Lake has no pollution, Winnisquam Lake is moderately polluted and New Hampton Stabilization Pond is an oxidation pond, or sewage lagoon, which is extremely polluted. A comparative study of this nature will assist in the maintenance of a high quality water supply.

Weekly samples will be taken at New Hampton Stabilization Pond, while collections will be made on alternate weeks at Winnisquam and Newfound Lakes. Samples from New Hampton Stabilization Pond will be primarily restricted to phytoplankton and floating mats of algae, while those from Newfound and Winnisquam lakes will include the attached bottom forms and the epiphytic types as well. The types, abundance, and occurrence of algae at all three areas will be enumerated throughout the year. Various techniques will be employed - Sedgwick-Rafter slide technique as outlined by Palmer (1959), a modificaton of the Hess Method for floating vegetation, collection of host plants and epiphytes, bottom sampling by dredging. Statistical differences will be determined between the various populations and areas studied. Routine culturing of several of the algae will be an integral part of this study - for identification of species and determination of nutrient requirements.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0019, RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS

D.N. RIEMER, Rutgers the State University, School of Agriculture, *New Brunswick, New Jersey* 08903

The proposed research plant involves controlled, replicated, field experiments in a series of twelve, one-tenth acre artificial, earth bottom ponds to determine the effects of various water quality parameters on the growth of aquatic plants, including algae. The research will be conducted by initially manipulating nitrogen and phosphorus levels in the water and measuring vegetative growth along with other parameters of water quality. Treatments in succeeding years will be dependent partially on the first years results and will involve different levels of organic carbon in addition to nitrogen and phosphorus manipulation.

The results of this research will aid in understanding the process of eutrophication and will delineate those factors most important in causing eutrophic conditions in ponds and lakes.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0020, THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS

D.N. RIEMER, Rutgers the State University, Agricultural Experiment Sta., *New Brunswick, New Jersey* 08903 (NJ00149)

OBJECTIVE: Study the growth and development of Myriophyllum, Potamogeton, and Elodea in axenic or algae - free cultures as affected by: Chemical variables, physical variables and biological variables and relate the results obtained to the distribution, management and control of the above mentioned genera.

APPROACH: Plants will be grown in plastic lined stock watering tanks with either filamentous algae or planktonic algae or in tanks kept free. Growth will be measured and observations made on root development, tuber development, flowering, etc. Laboratory test will be conducted on plants grown in various nutrient solutions to determine the effects of varying levels of N, P and K and under different photoperiods to determine the effect of day length on vegetative growth and flowering. Germinating seeds of Potamogeton and Myriophyllum, at different temperatures in germination chambers.

PROGRESS: To determine effects of photoperiod on aquatic plants had no definite conclusions because of algae in the experimental vessels. Copper sulfate has been used to control algae in aquatic experiments but effects of the copper on the rooted plants are not known. Experiments were conducted to determine effects of a range of CuSO(4) 5H(2)0 levels in sago pondweed and Eurasian watermilfoil. Sago pondweed plants were grown in nutrient solution from tubers planted in washed sand. CuSO(4) 5H(2)0 was added at 0, 0.5, 10.0, 50.0 and 100.0 ppm. Browning of leaf tips was observed on all plants with 10 ppm and above at 24 hours. Stunting of plants was evident at 50 and 100 ppm after [illegible] days and there was no increase in height of plants after 8 days. Plants with 0.5 and 10.0 ppm CuSO(4).5H(2)0 were shorter than controls after 6 days. Root development was inhibited in all plants treated with 10.0 or more ppm. Dry-weight yields were lower in all copper sulfate treatments than they were in the controls. Result with Eurasian watermilfoil were similar although this species did not grow well in the nutrient solution used.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

4.0021, A PROPOSAL TO STUDY PHOSPHATE INDUCED ALGAL GROWTH IN ORDER TO SUPPRESS OR ELIMINATE THIS PHENOMENA

N.E. VANDERBORGH, Univ. of New Mexico, School of Arts, *Albuquerque, New Mexico* 87106

A literature survey concerning phosphate induced algae growth in natural water systems has been carried out as an initial step in proposed research intended to study and eliminate this phenomenon.

The proposed research program provides for a theoretical analysis of the problem of algae growth induced by phosphates, both linear and cyclic, and an experimental, kinetic study of phosphate induced, algae growth rates employing P32 spiked phosphates, poly-phosphates and metaphosphates. The principal experimental studies proposed are: 1. Determination of which phosphate or mixture of phosphates offers optimum inducement for algae growth. 2. Determination of the activation energy for the growth process by measurement of growth rate constants and preparing Arrhenius Plots. 3. Evaluation of the methods for eliminating phosphate contribution to algae growth in accord with the postulated mechanism for growth found in 2), and examination of the variables affecting growth in the presence of phosphates, i.e., pH concentration, ionic environment, species of bacteria and phosphate, applied potential, dialytic membrane type, pore size, and time of equilibration.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0022, STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE

J.M. KINGSBURY, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00115)

OBJECTIVE: Investigate: in the Cyanophyta, ecologically induced morphological variation, and motility, resistance, pigmentation, reproduction, dormancy, perenniation, morphogenesis and ecology of selected species; in Chlorophyta, ecological life histories, and cytological life cycles of selected species.

APPROACH: Isolations, cultures and magnification (light, interference, and electron microscopes) are the main techniques for 1 a b and 2 b. Ecological life histories is a field project involving observation of algal population changes and life cycles in natural and controlled habitats. Parts of these studies will be carried out as graduate student problems.

PROGRESS: (1) Aquatic Weeds Ponds. Data for third year have been obtained; plankton sampling completed. Laboratory enrichment experiments undertaken and completed. 2. Ecology of Cyanophyta. Electron micrograph techniques worked out for Lyngbya and Merismopedia. Major differences found in structure of photosynthetic apparatus and in ultra structure of the cell in general between 'bleached' and normal- colored cultures. 3. Isles of Shoals. Transect data collected for the fourth season, and a preliminary integration of these data for the first four years prepared. Transect study for 1970 will be suitably modified. 4. Irish Moss ecology. Stations emplaced at Rocky Point and Manomet Point and periodic observations begun. Single-spore-isolate cultures now vegetatively mature (1 1/2 yr. old) but not reproductive. Cytological techniques worked out for successful nuclear staining to demonstrate chromosomes. Laboratory facilities established at New London, Connecticut for rate-of-growth experiments parallel to rate-of- growth observations at the experimental field stations. 5. Onondaga Lake. Sampling completed, data under review. The second season was not parallel with the first in several respects, especially absence of serious blooms of bluegreen algae, and the complete and unexplained clearing of the lake for about a week in midsummer. 6. Pesticides. Some, but not other genera of bluegreen algae metabolize DDT to DDE. This process is light-dependent.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

4.0023, EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II

H.F. MULLIGAN, State University of New York, School of Agriculture, *Ithaca, New York* 14850

This project involves the study of the effects of enrichment with ammonium, nitrate, and calcium monobasic phosphate hydrate on the growth of plankton algae and selected species of aquatic weeds in twenty, 1/10 acre experimental ponds. The aquatic weeds are being studied in the ponds include Elodea canadensis, Potamogeton crispus, and Myriophyllum spicatum var. exalbescens. Enrichment replications have been established in these ponds during the summers of 1968 and 1969. In the summer of 1970, no fertilizer will be added and bi-monthly estimates of the rates of growth of plankton algae and bottom weeds will be obtained. The species composition and succession of plankton algae and records of bottom weed populations will be noted.

In this way, effects of prior fertilization or species diversity and density of plankton algae and bottom weeds can be evaluated. Residual effects of nutrient enrichment on the entire aquatic ecosystem will be estimated by measuring nutrient composition of the soil and water on a bi-monthly basis.

These data will be summarized so as to provide information on the ecological consequence resulting from a reduction or cessation in nutrient enrichment to surface waters.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0024, ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS

H.F. MULLIGAN, State University of New York, Agricultural Experiment Sta., *Ithaca, New York* 14850 (NYC00079)

OBJECTIVE: Study the growth and development of Myriophyllum, Potomageton, and Elodea in axenic or algae-free culture as affected by chemical, physical and biological variables and relate the results obtained to the distribution, management, and control of these genera.

APPROACH: The three genera will be grown at different nutrient and pH levels and under different light, temperature, and photoperiod conditions with measurement of effects of pertinent variables on shoot growth, flowering and seed germination. Nutrient pathways will be followed with P. The competition among genera and with algae will be studied.

PROGRESS: Chara spp. and Myriophyllum spicatum var. exalbescens were eliminated from the high fertility ponds while Potamogeton crispus and Elodea canadensis showed their best growth in 1969 in the ponds which were heavily fertilized in 1968 and unfertilized in 1969. The major differences persisting in the ponds where heavy fertilization had been curtailed are: changes in the species composition of weeds, and a gradual reduction in numbers of species. The total yields of large weeds and phytoplankton densities remained approximately the same as in the controls. In 1969, the yield of the plants from the highly fertilized ponds and controls were nearly the same. Thus, it appears that when nutrient enrichment is curtailed, aquatic ecosystems recover rapidly. The control ponds showed a slight increase in weed yield in 1969 over the 1968 valued. The low fertility treatments had no effect on aquatic weeds in 1968 but 10x that fertility level inhibited their growth. An experimental program was initiated in the Finger Lakes, designed to evaluate the growth of aquatic weeds under natural conditions. A surveillance program was carried out to determine the distribution, abundance and rates of growth of Myriophyllum spp. in the shallow zones of these eleven lakes.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

4.0025, NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE

J.K. NEEL, Univ. of North Dakota, Graduate School, *Grand Forks, North Dakota* 58201

The primary objective is determination of the effects of weed harvesting upon nutrient level and utilization in a waste enriched lake. The general approach is aquisition of a limnological baseline prior to weed removal and then determination of changes attributable to biomass removal and reduced weed populations. Pre- and post-harvest evaluations will rest upon variation in physical and chemical lake characteristics and weed and phytoplankton populations, primary production by planktonic and attached vegetation, nutrient interactions among water, organisms, and sediments, inflow and outflow of nutrients via surface streams, and overall controls exercised by basic lake and weather conditions. These data should also indicate fundamental consequences of long term enrichment, particularly as affecting lake succession, conditions favoring ascendancy of weeds and phytoplankton, and potential of intra- lake cycling of waste nutrient residues.

4. AQUATIC PEST ECOSYSTEMS

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

4.0026, THE CHANGING DISTRIBUTION OF THE GENUS POTAMOGETON (PONDWEEDS) IN OHIO

R.R. HAYNES, Ohio State University, Graduate School, *Columbus Ohio* 43210

No summary has been provided to the Science Information Exchange.

SUPPORTED BY Amer. Assn. for the Advancement of Sci.

4.0027, INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER

R.M. PFISTER, Ohio State University, Graduate School, *Columbus, Ohio* 43210

The proposed investigation is to study the interaction of environmental contaminants (defined as substances not formed biologically or naturally, and which are not normally indigenous to the water) on the microbial portion of the ecosystem. The particulate materials (detritus) will be examined on a physical, chemical, and biological basis, and the materials will be characterized using differential and gradient centrifugation in conjunction with electron microscopy. The characteristic fractions of suspended particulate material will ultimately be examined for ability to influence biological reactions. This particulate fraction of water is important to microbial relationships in the area of interfaces and biological activity. It is known that particles and molecules in solution accumulate at interfaces (this includes chemicals which can either act favorably (e.g., nutrients) or unfavorably (e.g., pesticides) to organisms) and that enzymatic reactions are concentrated at membranous surfaces. Therefore, it is of significant importance to study the capabilities of non-biologicals that commonly end up in the waters on such colloidal or molecular interfacial systems.

The investigation will be confined to a small river or creek basin which enters into Lake Erie, and to the lake itself.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0028, AQUATIC PLANTS OF POLLUTED WATERS IN SOUTHWESTERN UNITED STATES

D.S. CORRELL, Texas Res. Foundation, *Renner, Texas* 75079

Description: The project objective is to produce a descriptive and illustrated manual of the nearly 1200 species found in southwestern United States. Specifically, the product of this research will enable one to identify these plants in this part of the country and to learn something about their role in the pollution or clarification of water. The work is meant to be especially useful for biologists, hydrologists, hygienists and wildlife management personnel who are concerned with organisms that might affect water quality. Data on ecology and distribution of the plant species, a discussion of methods of dissemination, reproduction and growth habit of the various entities will also be included where possible.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

4.0029, EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE

W.T. HELM, Utah State University, School of Natural Resources, *Logan, Utah* 84321

Bear Lake at the present time is a clear oligotrophic lake. With the recent increase in recreational use of the area, however, a number of boat harbors and breakwaters have been constructed. These structures have interrupted the normal shoreline currents. Along unprotected shores, the currents scour the bottom, limiting the amount and diversity of rooted vegetation and bottom organisms. Modification of this habitat by creating relatively quiet pockets protected from the wind driven water currents has encouraged the growth of a wide variety of organisms. The non-turbulent circulation pattern in these areas insures the retention of at least part of any intruding nutrient-rich water. The reactions of the rooted vegetation and benthic invertebrates to this altered environment will provide an assessment of the advisability of permitting such manipulations of the environment.

Measurements of selected physical and chemical parameters will be made at distances of a few millimeters to a meter or more from the bottom. Samples of plants and animals living on and in the bottom sediments will be collected in the same areas to determine how the differences in environment are expressed in the biota. Samples will be obtained from regions sheltered by breakwaters and harbors as well as from open, exposed littoral regions.

SUPPORTED BY U.S. Dept. of Interior - O. Wtr. Res. Rch.

4.0030, TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS

G.C. GERLOFF, Univ. of Wisconsin, School of Letters, *Madison, Wisconsin* 53706

The primary objective of this project are (1) to develop a procedure for assessing the nutrient status of lakes and streams and (2) to identify essential nutrients which might control the growth of nuisance macrophytes. These objectives will be accomplished through the application and refinement of a technique known as tissue analysis. This technique uses the concentration of an essential nutrient element in a plant as an indication of the availability of the element in the environment in which the plant grew. Critical levels for each of the essential elements will be established in laboratory experiments for two nuisance macrophytes (Elodea occidentalis and Ceratophyllum demursum). These same species then will be collected from a number of Wisconsin lakes and will be analyzed for all the essential mineral elements. The analyses will be compared with the established critical levels for indications that one or more elements became limiting for plant growth.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

4B. AQUATIC INSECTS

4.0031, ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE

C.C. ROAN, Univ. of Arizona, Agricultural Experiment Sta., *Tucson, Arizona* 85721 (ARZT-2014-4161-017)

OBJECTIVE: Determine the nature and extent of occurrence of arthropods of medical and veterinary importance in Arizona. Develop more efficient methods of pest population management that will minimize the use of pesticides or/and pesticide residues in man's environment and food supplies.

APPROACH: Conduct comprehensive survey to listing hosts, economic import areas, etc. versus species of arthropod pests and diseases vectored or nature of pest activity. Current practices of pest control will be solicited and validated by selected random interviews and inspections. The approach to the second objective depends on the outcome of the first. In the interim, an investigation of control practices involving ectoparasites of small animals will be initiated. The preferred host-parasite for this phase is the dog tick complex.

PROGRESS: Maintenance of a colony of the brown dog tick without animal facilities is impossible. Continued field surveillance of native populations may establish rather firmly life cycle patterns in this geographical area. Evaluation of control procedures without experimental colonies and animals is impossible. Aggressive antagonistic behavior between Culex tarsalis and Culex quinquefasciatus larvae has been observed via photography. In rearing studies of varying population densities, Culex quinquefasciatus is usually dominant over Culex tarsalis. A program of evaluating the behavior of ULV particles of a rather homogeneous particle spectrum in control of insects of public health importance is being initiated.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

4.0032, TRANSMISSION OF ANAPLASMOSIS

J.L. LANCASTER, Univ. of Arkansas, Agricultural Experiment Sta., *Fayetteville, Arkansas* 72701 (ARK00637)

OBJECTIVE: Determine role of biting flies, mosquitoes, and ticks in transmission of anaplasmosis.

APPROACH: In laboratory species reared, or acquired in immature stages, for transmission tests to determine ability to pick up organism. Fluorescent antibody technique to determine presence of organism in tissue of test species. Infection of test species does not necessarily mean that organism can be passed on to susceptible bovine host. Therefore, its ability to transmit will be tested. In the field, vector species will be collected from infected animals. These vectors tested by fluorescent antibody technique for presence of organism.

PROGRESS: Seasonal incidence of suspected vectors and relative numbers were learned. No absolute vector was definitely established. It appeared that vaccination of all the cattle surrounding the test herd had a marked influence on the rapidity of transmission in the test herd. The number of potential vectors collected was increased through the use of dry ice baited sticke traps. Species not taken in an animal baited trap were taken by this method.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

4.0033, THE NUTRITION AND BEHAVIOR OF MOSQUITOES

R.H. DADD, Univ. of California, Agricultural Experiment Sta., *Berkeley, California* 94720 (CA-B-PAR-2439)

OBJECTIVE: Study general feeding behavior, characteristics of food that stimulate feeding, nutritional requirements and relationships between nutritional and ovipositional responses of gravid females, and investigate possible effects of both larval and adult nutrition on the viability and virulence of both pathogens and parasites of mosquitoes and these transmitted by females.

APPROACH: Study dietary feeding rates of larvae and demand related to food type, method offered and relate this to adult fecundity.

PROGRESS: Analysis of larval feeding behavior has continued. Effect of particle size on rate of ingestion was studied using polystyrene latex particles of specified diameter. Ingestion by 2nd, 3rd, and 4th instar Culex pipiens larvae was optimal with particles in the range of 1-10 u diameter. A stimulatory effect of solutes on ingestion, presumeably gustatory, was first indicated in experiments using soluble yeast extract in combination with inert particulates such as alumina. Pure chemicals are now being tested for similar effects. Amino acid mixtures at concentrations of about 1% slightly increase ingestion rates. Sugars are inactive. Crude yeast and sperm nucleic acids at low concentrations (0.1%) markedly increase ingestion rates, yeast adenylic acid alone having a similar action.

SUPPORTED BY California State Government - Sacramento

4.0034, FEEDING HABITS OF MOSQUITO LARVAE

R.H. DADD, Univ. of California, Agricultural Experiment Sta., *Berkeley, California* 94720 (CA-B0-PAR-2550-H)

OBJECTIVE: Assess what mechanical properties of particulate materials and what chemical factors associated with them or dissolved in water may influence larval feeding rates.

APPROACH: A method (published) for comparing rates of ingestion of particulate materials by mosquito larvae has shown that ingestion is affected by both physical properties of particulates and by nutrient, probably phagostimulant, material (yeast extract) dissolved in the water. The method will be extended to compare relative ingestion for particulates of different particle dimensions, density, and concentration in the water phase. With gustatorily inert particulates, effects of soluble nutrients and possible phagostimulant defined chemicals will be examined. Having established what factors regulate feeding, the potentials inherent in manipulation of feeding rate upon larvicide efficiency, and the adequacy of nutrient media will be explored.

PROGRESS: This new project directly continues the feeding behavioral studies, reported under discontinued project 02439, which showed that the rate of ingestion of particulate material by larval Culex pipiens was increased by phagostimulant solutes, such as yeast extract. Among various simpler chemicals tested for phagostimulant action, adenylic acid and other nucleic acid components proved highly effective. Phagostimulation was first detected by comparing the rate at which inert particulates moved down the guts of larvae placed in water or solutions of potential stimulants. It was surmised that faster ingestion resulted if larvae were stimulated to main filtering movements for a greater proportion of time. This is now established, from continuous recordings of filtering activity of individual larvae in various solutions, with or without suspended particulate. In suspensions, of yeast, kaolin, or latex, ingestion and movement down the gut is proportional to the duration of actual filtering. With phagostimulants in solution, ingestion is faster and the proportion of time spent filtering greater. These changes in filtering activity occur whether or not particulate is present, providing a most convenient alternative method for rapidly assessing whether a substance is phagostimulant. In the ideal case, a larva that is quiescent in water immediately 'switches on' sustained filtering on addition of a powerful phagostimulant.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

4.0035, DEVELOPMENT OF CULTURE METHODS FOR MOSQUITOES

C. SCHAEFER, Univ. of California, Agricultural Experiment Sta., *Berkeley, California* 94720 (CA-B0-PAR-2455)

OBJECTIVE: Develop culture methods for Aedes nigromaculis and other mosquitoes. Maintain lines of mosquitoes for experimental use by University campuses and cooperating agencies.

APPROACH: Artificial mating of mosquitoes will be studied since this is the usual reason for failure in colonization attempts. Studies will be made of such factors as temperature and feeding of immature mosquitoes as they affect larval survival. Laboratory colonies developed in this project will be used to study the susceptibilities of the various species to detrimental influences, such as insecticides, and they will be used for supplying subcultures to other laboratories.

PROGRESS: An evaluation of mass-rearing Aedes nigromaculis by induced-mating methods was completed. With experience, an average person is able to inseminate 15-20 females per hour; the average egg production was 46 eggs per female (range 15-89) and 60% of the total eggs obtained were viable. A study of sexual dimorphism, with emphasis on the lesser conspicuous sex characters, of Aedes nigromaculis adults has been completed. The dimorphism with respect to size of the compound eyes, shape of the clypeus, occiput, tarsal claws and tarsomeres and scaling of the wings was described. In addition, four gynandromorphs were examined and described with respect to the characters studied above. Colonies from six Culex tarsalis field populations were established at the Fresno Laboratory during 1969. Five of these colonies are highly organo-phosphorus-resistant; one of the five will be selected for maintenance at Fresno to provide material for insecticide testing.

SUPPORTED BY California State Government - Sacramento

4.0036, CULTIVATION OF INSECT PHASE OF AVIAN PLASMODIA

G.H. BALL, Univ. of California, School of Letters, *Los Angeles, California* 90024

Oocysts of Plasmodium relictum will be cultured with mosquito cell lines from Aedes aegypti and Culex pipiens in order to determine the contributions of these cells to the in vitro development of the oocysts and other stages of this malaria parasite. Similar studies will be made with cells of primary cultures of Culex tarsalis. Efforts will be continued to develop a cell line of C. tarsalis. Further work will be carried out on the suitability of mosquito cell lines for the cultivation of blood parasites other than those of malaria. The overall objective of the research is the determination of the biochemical nature of the dependence of a parasite on its host.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

4.0037, MOSQUITOES OF MIDDLE AMERICA

J.N. BELKIN, Univ. of California, Graduate School, *Los Angeles, California* 90024

Objective: To collect, describe and illustrate in detail all species of mosquitoes known to occur in middle America and adjacent parts of North and South America and to assemble and summarize all available information on the distribution, bionomics, and the ability of these species to transmit disease to man in military situations.

Approach: The project will employ the cooperative services of a large number of culicidologists familiar with specific local areas. The central clearing office and coordinating activity will be at the University of California in Los Angeles.

Material was collected and reared by the staff and cooperators in Venezuela, Virgin Islands and Southerwestern United States. More than 2000 collections were processed and about 4800 slides of individual rearings, 300 slides of whole larvae, 480 slides of male genitalia and 23,000 mounts of adults were prepared. Manuscripts were completed on the subgenus Micraedes, 2 new species of Deinocerites and a new Aedes from Southern California. Studies were completed on the Terrens group of finlaya and the Culicidae of Jamaica. Eight papers were published during the period, among them a revision of the subgenus Howardina, a new anopheles from the Southewstern United States, and on the pupae of the genus Psorophora.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0038, MOSQUITOES OF MIDDLE AMERICA

J.N. BELKIN, Univ. of California, School of Letters, *Los Angeles, California* 90024

The project is concerned with detailed studies on the 'systematics, bionomics, distribution and vector potential of the mosquitoes of Middle America' (Central America and the West Indies and the adjacent portions of North America and South America) with the principal objective of providing basic biological data needed for the control of 'mosquito- borne diseases', some of which may be spread to the United States.

The specific aims and methodology of the project are: (1) To undertake and publish comparative studies (as in 3 and 4 below) of various natural groups of mosquitoes as sufficient material becomes available, with the long-range objective of the publication of a comprehensive monograph of several volumes that will cover entire fauna. (2) To carry out additional field collections, observations and rearings (individual, progeny, mass) to obtain topotypic material in areas not adequately surveyed in the past and for groups requiring additional information. (3) To describe and illustrate in detail every species in every stage (female, male, pupa, 4th-instar larva) on the basis of individually associated reared material from type localities insofar as possible. (4) To summatize for every species data on bionomics and distribution recorded on a standard form developed for the field surveys of the project as well as from the literature and to evaluate from these data the disease vector potential of every species.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

4.0039, ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA

R.M. CHEW, Univ. of Southern California, School of Letters, *Los Angeles, California* 90007

The objective is to understand as much as possible of the ecology of the arid and semiarid portions of southeastern California, parts of which are now subject to irrigation. 'Culex tarsalis,' 'Culiseta inornate' and 'Psorophora confinnis' are ubiquitous in the area; 'Aedes vexans' and 'Anopheles p. franciscanus' are wide spread but less frequent; ten other species have limited distributions and frequencies. The peaks of abundance of the eight most common species are almost mutually exclusive. The feeding patterns of the six most abundant species in this area are not significantly different from their patterns in other regions. Salinity, pH and organic nitrogen are not limiting factors on distribution of 'C. tarsalis' and 'C. inornata.' Certain other species are associated with limited ranges of water conditions, but probably as a secondary effect of their habits in breeding in temporary waters or streams in high desert canyons. Linear regression was developed as a means of comparing the frequency of presence of ten species of mosquitoes with the corresponding values for frequency of association of these species. Possibly this can be used to compare nonquantitative samples of adults and larvae of these species. Work is continuing on the effects of the type of host blood on the fertility of 'Culex tarsalis', on the effects of level of feeding, temperature, and pattern of fluctuation of temperature on the rate of development of 'C. tarsalis,' and the attraction of 'C. tarsalis' of different physiological states to light in the laboratory. A field study is underway to evaluate the numerical relationship between adult and larval populations at a single site.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

4.0040, (U) REPELLENCY AND ATTRACTIVENESS OF MAN TO MOSQUITO BITES

W.A. SKINNER, Stanford Research Institute, *Menlo Park, California* 94025 (DA-49-193-MD-2465)

Objective: To study in depth the attractiveness and repellency of the natural secretions of man to mosquito bites and to develop effective mosquito repellents.

Approach: The following methods ar being utilized: (1) Isolation by chromatographic methods of the factors in human sweat that attract Aedes aegypti. (2) Isolation by chromatographic methods of the repellents present in human skin surface lipids. (3) Identification of these repellents and attractant factors. (4) Synthesis of more effective topical repellents.

Progress: Skin-surface lipids, which have been found repellent to mosquitoes, have been fractionated by vacuum distillation and thin-layer chromatography. Unsaturated hydrocarbons from these lipids, although repellent, do not account for the strong repellency noted with certain lipid samples. Human sweat contains repellent substances and attractive substances that can be separated by lipid-extraction with diethyl. The repellent substances in the other phase include lactic acid-lactic anhydride mixtures and two other polar substances not yet identified. Surveys of various individuals for PT50 (time for 50 percent of the mosquitoes in a cage over the arm to probe) measurements, attractiveness of their sweat, and repellency between these parameters.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0041, ATTRACTIVENESS AND REPELLENCY OF MAN TO MOSQUITO BITES

H.I. MAIBACH, Univ. of California, School of Medicine, *San Francisco, California* 94112

Objective: To study factors determining attractiveness and repellency of mosquitoes in man in order to develop a more efficient system of preventing the mosquito bite.

Approach: (1) To fractionate body emanations for attractive and repellent substances; (2) Mosquito behavior studies which will deepen understanding of host-seeking behavior; (3) Studies of factors modifying human attractiveness, such as illness and medication; and (4) synthesis of new repellent compounds.

An annual progress report, dated 15 Sep 69, has been received which includes details on the following areas: (1) Quantitative study of the variation of the mosquito response and host attractiveness. (2) Increased attractiveness of man to mosquito with induced eccrine sweating. (3) Differential attraction of the yellow-fever mosquito to vertebrate hosts. (4) Human trials of possible oral systemic repellents - thiamine hydrochloride. (5) Standardization of the dual-port olfactometer. (6) Trapping of volatile mosquito attractants from skin (other than eccrine sweat), and (7) An alternate method of testing insect repellents, for details, see Annual Report.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0042, PUBLICATION OF BIBLIOGRAPHY OF MEDICAL ENTOMOLOGY

D.L. COLLINS, Amer. Mosquito Control Assn., *Selma, California* 93662

Mosquito News: The official journal of the American Mosquito Control Association is now in its 29th year. It is published quarterly, in March, June, September and December, each annual volume running more than 600 pages. For the past 14 years a feature of each issue has been a section of Bibliography, or 'Reference to Literature of Interest to Mosquito Workers and Malariologists,' which now runs 12 to 14 pages per issue (a total of 56 pages in Vol. 28 for 1968). Begun with Dr. F.C. Bishopp, Mrs. Helen Sollers-Riedel has continued as editor-in-charge of this section. She keeps it continuously up to date from library research and world-wide correspondence, and since the journal is published quarterly it comprises possibly the most up-to-date source of references in medical entomology available anywhere.

Our research objective is not only to continue to publish this bibliography, but to be able to enlarge it as necessary to keep up with the increasing number of titles and to include better subject classification and cross- and cumulative indexing to make it even more useful.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

4.0043, BIOLOGICAL STUDIES OF CULICOIDES AND THEIR CONTROL IN THE CANAL ZONE

L. JOHNSTON, U.S. Army, Environmental Health Division, *Fort Clayton, Canal Zone*

Technical Objective: To investigate and define- (1) the life histories of Culicoides spp, affecting man and animals in the Canal Zone and adjacent Republic of Panama, (2) the reproductive capacity of the primary sandfly pest, Culicoides furens, and its bionomics in its natural mangrove breeding habitat versus sediment spoil areas, and (3) larval and adult Culicoides control measures by biological, physical and chemical measures.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0044, ECOLOGY AND DISEASE TRANSMISSION POTENTIAL

F. MEDEM, Univ. Nac. De Colombia, *Bogota, Colombia* (AF-AFOSR-1418-68A)

The scope of this proposed research project is to continue studies on colombian animals. Only selected species are to be investigated in relation to their habitat, alimenation, parasites, reproduction and geographical distribution. Some of the benefits resulting from these accomplishments will be as follows: 1. Field observations and inestigations about the effect of isolation in relation to evolution, life history and behavior. 2. Collections of endo- and extoparasites will be idenified and studied as possible vectors of transmittable diseases. 3. Sound ecological studies would contribute considerably to the formation of international agreements about protection and preservation of animals which are either in danger of experimentation. 4. Specimens collected would be maintained in Colombia and the United States where they will be safe and accessible to future investigators.

Field studies were carried out within seven different river systems. About three hundred horseflies (tabanidae), belonging to eight different species, were collected mainly from caimans (crocodiles), but also from mammals, including humans. Horseflies are strongly suspected to transmit the larvae stages of filaria (micro-filaria). Adult filaria, belonging to a new species, were found in the somach of the smooth-fronted caiman. The smooth-fronted caiman (caiman sclerops) form the hosts for five different horseflies. Three species feed exclusively on caimans while two others may also feed on humans. Three horseflies (tabanus fervens, and two unidentified species) feed exclusively on the head, where the skin is still irragated by blood capillaries. An other unidentified species feed on both head and body. Tabanus modestus, however, feeds exclusivey on the body, perforating the sutures between the scales from neck to tail, and on the fore and hind legs. Their feeding period takes place during the dry season only. Another species feeds on humans. In contrast to turtles, caimans contain few intestinal worms.

SUPPORTED BY U.S. Dept. of Defense - Air Force

4.0045, BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES

R.H. JONES, U.S. Dept. of Agriculture, Entomology Research Division, *Denver, Colorado* 80225 (00ENTH0103060300)

OBJECTIVE: Determine and explore how to prevent insect transmission of bluetongue in sheep and cattle; seek possible vectors, delineate their roles and evaluate control measures.

APPROACH: Colonize and rear disease-free sand flies and mosquitoes and with veterinarians, engage in coordinated research in virus transmission trials with these and other insects. Make epidemiological studies in the field and engage in vector control research with promising chemicals.

PROGRESS: A line of culicoides variipennis flies, highly susceptible to infection with bluetongue, has been developed. This colony has nearly a 100% infection rate compared to only 17% for the parent colony. An intermediate susceptible colony was stable, with a 65% infection rate for the F(1), F(3), and F(7) generations. A resistant colony has also been developed. The development of these completely divergent lines from the same parent stock is highly significant; we now have known material for genetic studies to determine the mechanism of bluetongue transmission by a vector, and for morphological-physiochemical investigations on differences between resistant and susceptible lines. The resistant colony provides a possible control procedure through the field release of genetically resistant males. An improvement in our colonization procedures for C. variipennis was the development of a bacterial broth as a larval medium. Transovarian transmission of bluetongue was shown unlikely for this species. With a 100-fold dilution of the virus, insufficient to infect 100% of the flies genetically capable of becoming infected, 3 repeated infective meals resulted in an increase in the infection rate in anarithmetic progression. With a 4th infective blood meal, the infection rate dropped off. A 10-fold dilution infected 100% of flies capable of becoming infected; no flies were infected at the 1000-fold dilution.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

4.0046, ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS

B.F. ELDRIDGE, U.S. Army, Walter Reed Army Inst. Res., *Washington, District of Columbia*

Studies emphasize control of vectors of arbovirus and parasitic diseases of military significance. Objectives are incrimination of vectors and understanding of host-parasite relationships initially. Understanding of vector biology and disease transmission mechanisms ultimately in order to develop more effective control procedures.

Invertebrate vectors and vertebrate reservoirs and hosts are collected in areas of known disease activity. Infection rates are determined, as are flight ranges, blood meal sources, breeding habits. and other biological characteristics. Other biological processes, such as pathogen transmission, flight physiology, and diapause are studied in the laboratory.

Over 300,000 mosquitoes collected in an area in Maryland endemic for arbovirus diseases. 19 isolations of EEE and WEE viruses obtained all from culiseta melanura. Larval breeding habits and seasonal distribution determindd for dominant mosquito species of area. Factors responsible for infection of 2 species of tsetse flies with trypanosomes have been partially determined. Blood meal source of 200 engorged mosquitoes of 2 species determined. Five species of mosquitoes tested for flight ability on mechanical flight mill. For technical report see Walter Reed Army Institute of Research Annual Progress Report, 1 Jul 69 - 30 Jun 70.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0047, BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN

J.B. GAHAN, U.S. Dept. of Agriculture, *Gainesville, Florida*

Objective: Determination of the environmental stimuli and physiological responses that govern the activities of selected disease vectors in finding food, mates, and/or oviposition sites and in the consummatory bheavior associated with feeding, mating, and/or ovipositing, and the utilization of the acquired information in developing more effective control methods.

Approach: Physiological studies are made with preparations of whole insects or excised organs to record electronically the neural activity generated by exposure of sensillae to chemicals, light, and/or sound. Various olfactometers are used to study behavioral responses in the presence of specific chemical stimuli, presented individually or in competition with each other under a range of environmental conditions, to isolate and identify insect attractants and feeding, mating and oviposition stimulants.

4. AQUATIC PEST ECOSYSTEMS

Studies were conducted relating to the behavior of Psorophora spp. and anopheles quadrimaculatus in buildings. During the daylight hours Psorophora were scarce but a. quadrimaculatus were prevalent inside many farm buildings. A. quadrimaculatus was most numerous in structures that housed farm animals, though it was also found in unoccupied buildings close to barnyards or pastures where animals were kept. A colony of stable flies, Stomoxys calcitrans, has been established and studies will be initiated relating to mass rearing procedures, laboratory biology, and population dynamics.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0048, POPULATION DYNAMICS OF MOSQUITOES IN FLORIDA

W.G. EDEN, Univ. of Florida, Inst. of Food & Agric. Sci., *Gainesville, Florida* 32601 (00ENTH01191001CA)

OBJECTIVE: Determine the population dynamics of Culex pipiens quinquefasciatus.

APPROACH: The relative densities of this mosquito as it occurs throughout the year will be determined. The seasonal variation in time length of the stages and preoviposition period, survival of adults, and dispersal patterns will also be determined.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

4.0049, COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM

E. VANHANDEL, State Div. of Health, *Vero Beach, Florida*

Metabolism of biting arthropods: Feeding habits, survival without feeding, and dispersal of insects are reflected in their ability to store caloric reserves. The main objective will be a comparison of glycogen and triglyceride synthesis and utilization in adult, intact, mostly biting arthropods, following a single meal of protein (blood) or carbohydrate (sugar). When essential to an understanding of gross metabolism, work on digestion, absorption, or metabolic pathways will be included.

The natural history of trehalase and maltase: The recent finding of saccharidases other than trehalase in the hemolymph of the mosquito and other insects, led to the discovery of trehalase and maltase in the serum and the kidney of many vertebrates, including man. The diagnostic potential of these findings will be explored, both clinically and experimentally. Another objective, based on the same finding, will be to test the hypothesis that trehalose and maltose are intermediates in renal glucose transport.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

4.0050, MOSQUITOES OF THE NEW GUINEA AREA

W.A. STEFFAN, Bernice P. Bishop Museum, *Honolulu, Hawaii*

To carry out biological and taxonomic investigations of mosquitoes, to collect and rear specimens for systematic study, to investigate feeding behavior of adults, and to obtain distribution records from areas where little collecting has been done previously. The principal long-range objective will be the publication of a comprehensive monograph (in several parts) of the mosquito fauna of the New Guinea area in Pacific Insects Monograph series or Journal of Medical Entomology published by the Dept. of Entomology, Bishop Museum.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

4.0051, DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT

P. KASHIN, Illinois Inst. of Technology, Graduate School, *Chicago, Illinois* 60616

To study by various means, assays, various chemicals which could be utilized as an effective and safe oral insect repellent.

The efficacy of candidate substances are assayed with an electronic bite monitor developed in their laboratory. The apparatus detects the various phases of the mosquito bite, and responds only when actual penetration of the host skin by the insect mouthparts occurs. Another phase involves the elucidation of the mechanism of insect attraction on the basis of activation and inhibition in the insect nervous system. Repellents which interfere with or inactivate mosquito odor reception mechanisms will be investigated.

The isolated central nervous system of the cockroach, P. Americana, was utilized to test the effects of carbamino-gaba and other compounds on the nervous system of an insect. Gaba inhibited the spontaneous firing rate of this preparation in the absence of carbon dioxide, but stimulated it in its presence. Gamma-hydroxybutyric acid, a substance which cannot form a carbamino compound, was inhibitory both in the absence and presence of carbon dioxide. The evaluation of selected compounds for mosquito repellency by the electronic recording method was continued. Compounds were selected on the basis of their past approach, i.e., that volatile chemical analogues of gaba would affect the mosquitoes responses to its host.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0052, THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES

W.R. HORSFALL, Univ. of Illinois, Graduate School, *Urbana, Illinois* 61801

Aedes stimulans, because of its dependable responses to even minute differences in thermal regimens during morphogenesis, it is an excellent model for obtaining specific information on a timetable for differentiation of parts. Both larval and imaginal systems are being examined. Transplantation techniques developed earlier are being employed to determine how parts develop in the humoral environments under control of genetics for both sexual patterns. Effect on host and donor tissues are being studied. Additionally the cellular pattern of ovarian follicles is specifically distinctive and is being studied by electron microscopy.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. -
H.S.M.H.A

4.0053, DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS

R.T. HUBER, Purdue University, Agricultural Experiment Sta., *Lafayette, Indiana* 47907 (IND01494)

OBJECTIVE: Evaluate factors affecting light trap catches and correlate insect phenology with climatic data. Evaluate insect caused crop losses. Evaluate corn insect dynamics under different tillage- planting systems. Conduct insect surveys.

APPROACH: Adults will be released in a free-flight chamber and their response to a light trap measured at various temperatures and humidities. Light trap data will be used to develop phenological indices at 9 field sites. Corn yield data from infested and uninfested plants will be compared at 9 field sites and losses determined in time and space. The relative effects of conventional and specialized corn tillage-planting systems on insect dynamics will be studied at 3 sites. Surveys of major crops will be conducted during the growing season.

PROGRESS: Economically damaging alfalfa weevil infestations were present throughout the southern 3/4 of Indiana, with heaviest damage occurring on first growth alfalfa in the eastern and central districts relative to the western districts. The alfalfa weevil parasite, Bathyplectes curculiones, was very abundant in the Knox County area, and was also found in many areas of central and northern Indiana. Alfalfa weevil infestations are predicted to reach economic levels throughout Indiana during 1969. The spring and fall chinch bug survey revealed a slight increase in population levels during the growing season, but populations were not economically damaging in 1968. Second generation European corn borer infestations in field corn were the heaviest since 1957 on a statewide basis. Statewide, the fall corn survey showed that borer larvae averaged 82/100 plants. The corn leaf aphid was the major pest of corn in central and northern Indiana during 1968. The western corn rootworm was detected in Indiana for the first time in 1968. Face fly populations reached severely annoying levels on pastured cattle from mid-July to mid-August throughout Indiana. The face fly was at the highest levels ever encountered since the survey program began in 1964. Mosquitoes (mostly Aedes vexans) were severely annoying from late May through early August in central and northern Indiana. Populations were considered to be the heaviest in 15 years in many areas.

SUPPORTED BY Indiana State Government

4.0054, BIONOMICS OF SELECTED NORTH AMERICAN CULICINE MOSQUITOES

J.V. OSMUN, Purdue University, Graduate School, *Lafayette, Indiana* 47907 (DA-49-193-MD-2518)

The objectives of this project are to determine the mechanics involved in the overwintering of adult Culex in temperate regions to investigate the influence of environmental factors on their block feeding and to make observations and evaluation of associated activities.

Approach: The information thus obtained is to be related to aspects of mosquito bionomics as they relate to disease epidemiology, both field and controlled. Laboratory studies will be accomplished.

Progress: Gonotrophic dissociation was observed in a laboratory reared Culex pipiens) when incubated at 10-15 degrees C with short photoperiod, and held at a low temperature after feeding: but was sopradic in C. quinquefasiatus) after conditioning by low temperature, regardless of photoperiod. Concurrent laboratory and field studies are under way to determine if this phenomena will occur in a natural environment outsde the laboratory.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0055, GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES

G.B. CRAIG, Univ. of Notre Dame, School of Science, *Notre Dame, Indiana* 46556

This project focuses on genetics of 'Aedes aegypti', with some work on other 'Aedes' such as 'A. triseriatus', 'A. atropalpus' and 'A. simpsoni.' Research is divided into: 1. Formal genetics - more than 100 mutants isolated and linkage maps under construction, 2. Cytogenetics, with emphasis on chromosome translocations, 3. Genes of economic importance such as vectorial capacity for malaria and filariasis, 4. Reproductive physiology, with emphasis on hormones affecting mating and insemination, 5. Stock Culture Center, serving as the WHO International Reference Centre for 'Aedes' Mosquitoes with maintenance of 100 strains of 'A. aegypti' and 20 other 'Aedes' species. Field projects are currently under way in Nairobi, Kenya and Delhi, India, to develop measures for control of mosquitoes by genetic manipulation of populations.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

4.0056, OCCURRENCE AND BIONOMICS OF BLOODSUCKING MIDGES (DIPTERA: CERATOPOGONIDAE) IN IOWA

W.A. ROWLEY, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01729)

OBJECTIVE: Determine species of bloodsucking midges present in Iowa. Study breeding places, developmental requirements, and life histories of the most common and economically important species. Determine seasonal abundance and host preference of those species known to be anthropophilic or vectors of vertebrate pathogens.

APPROACH: Analysis of light trap collections obtained from selected ecological regions in the state will be made. Where practicable, adult emergence and malaise traps will be utilized to augment light trap data. Potential breeding places will be examined for immature forms of these insects, which will include alkaline and saline water-soaked soils. Other possible breeding areas will be sought. Laboratory holding and rearing procedures will be established when necessary to facilitate bionomical studies of important species. Adult and immature stages will be identified and when appropriate, described. Host preference of adults will be studied serologically.

PROGRESS: Bloodsucking midges were collected from an additional 7 counties in Iowa during this reporting period. The placement of light traps was designed to extend sampling procedures to southwestern, southeastern, and northeastern counties. Culicoides adults were collected in appreciable numbers from all light trap areas. Biting midge populations encountered in Malvern (southwest) and Durant (southeast) were the highest. High populations of C. obsoletus, an important anthropophilic species were encountered in Cedar and Bremer Counties. The commonest species collected throughout the state were C. crepuscularis and C. variipennis. Culicoides variipennis, the primary vector for blue tongue virus, was collected in appreciable numbers in all areas of the state. Studies on the species composition and abundance of Culicoides in 23 different larval habitats were completed during this study period. Results are being prepared for analysis using a coordination approach designed to show habitat relationships according to a series of similarities and dissimilarities. To date, 14 species of bloodsucking midges have been collected in Iowa. Six of these were taken in this state for the first time during this report period. Small numbers of adult midges were collected and are being maintained at a minus 70 C for future arbovirus isolation attempts.

SUPPORTED BY Iowa State Government - Des Moines

4.0057, ARTHROPOD-BORNE VIRUS (ARBOVIRUS) ACTIVITY IN MAJOR MOSQUITO VECTORS IN IOWA

W.A. ROWLEY, Iowa State University, Agricultural Experiment Sta., *Ames, Iowa* 50010 (IOW01788)

OBJECTIVE: Survey the mosquito fauna of Iowa to determine the presence and importance of primary vector species. Determine the extent of arbovirus activity in mosquitoes and other hematophagous insects. Isolate and identify specific arboviruses from vector species and assess their importance to the public health of the state.

APPROACH: Mosquitoes will be collected and identified throughout Iowa. Periods of high arbovirus activity will be compared to population levels of primary vectors species and changes in seasonal and climatic conditions. During the peak months of arbovirus and mosquito activity (July through September) mosquitoes will be collected, separated to species, and maintained at -60 C for virus isolations. Pooled groups of each species will be injected intracerebrally into suckling mice for initial virus isolation. Isolates will be serologically typed and/or sent to an arbovirus reference center for identification.

SUPPORTED BY Iowa State Government - Des Moines

4.0058, BIONOMICS AND CONTROL OF ASIAN MOSQUITOES -

A.A. HUBERT, U.S. Army, Med. Laboratory No. 406, *Zama Honshu, Japan*

Objective: Investigate bionomics and vector capabilities of Asian mosquitoes of the following species: A. sinensis, C. pipiens complex, C. tritaeniorhynchus and A. togoi. Data on arthropod-borne diseases are essential in implementing effective control programs.

Approach: Colonize medically important species for the purpose of conducting susceptibility-resistance tests. Determine vector capability of A. togoi and A. sinensis and utilize electrophoretic and immunological technique in the discrimination of various species of the C. pipiens complex. Adapt these species to laboratory conditions.

The following results are reported: 1. A. sinensis has been adapted to feed on guinea pig blood and the size of the mating cage has been reduced. 2. Biochemical tests utilizing electrophoretic techniques have been applied to several species of the C. pipiens complex. Preliminary results indicate no significant difference among these species - and 3. Screening of systemic insecticides to determine suitability of prophylactic agents for the prevention of dog heartworm infection has been completed. A. togoi was the vector species used for infection of test dogs. Vector capability will be known when dogs are sacrificed after sufficient time for development of adult worms has elapsed. Studies are being continued.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0059, INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA

S. OMINDE, Univ. of East Africa, *Nairobi, Univ. College, Kenya*

Ecological surveys, settlement and land use: Work is already in progress at University College on settlement and land use in the area of the Kano Plains; it is proposed to extend this to include geomorphological, hydrological and ecological data collection to provide the most up-to-date scientific information for regional planning.

Biological studies (proposed as Kenya's contribution of the IBP) preliminary data will be collected on three aspects of the ecology: a) productivity of fish in the lake shore region and the streams of the Kano Plains affected by migrations; this will be extended to include the fisheries potential productivity in the pilot irrigation scheme. b) the ecology of snails in the area. c) the ecology of mosquitoes, biting flies and other aquatic insects under water-logged and irrigation conditions - this survey to be correlated with current public health aspects already being studied.

Socio-economic problems: Experience in a pilot project has underlined the need for urgent investigation on both the immediate problems of attitude and impact of the far-reaching changes in the way of life of the people in the area outside the pilot scheme. The problem of population density and the impact of the change on existing traditional economy will be studied, including an inquiry into attitudes toward family planning.

SUPPORTED BY Rockefeller Foundation - New York, N.Y.

4.0060, MOSQUITOES OF MALAYSIA

S. RAMALINGAM, Univ. of Malaya, *Kuala Lumpur, Malaysia*

Objective: This is an integral part of the Wraar-Smithsonian Institution study of the mosquitoes of southeast Asia. The investigator will concentrate on the mosquitoes found in the central mountainous part of Malaysia. Predators and pathogens of the mosquitoes will be included in the study.

Approach: Field collections of all stages will be made and information on distribution, bionomics, and relationships to disease will be combined with a summary of current knowledge of mosquitoes in the area. Keys will be prepared.

Correspondence with the investigator indicates his work is proceeding on schedule. Varieties of specimen material are being processed locally and shipped to SEAMP.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0061, BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS

L.E. ROZEBOOM, Johns Hopkins University, School of Public Health, *Baltimore, Maryland* 21205

Mosquito biology and genetics. Cross breeding experiments will be carried out between species and other populations of the Aedes scutellaris group. If hybrids are obtained, the genetics of the inheritance of morphological or biological characters will be studied in detail. Attempts will be made at hybridization at the molecular level by extraction and recombination of DNA.

The ability of A. albopictus males to inseminate and thereby to sterilize females of the A. scutellaris group will be studied further, and more detailed knowledge of mating habits of the A. scutellaris group will be sought in a large, walk-in cage and in the field, as well as population densities and survival of larvae in their breeding habitats.

Host efficiency for pathogenic agents. A comparison of the species of the A. scutellaris group and A. albopictus and A. aegypti as hosts for the 4 wild strains of dengue virus will be made by infecting the mosquitoes by injection and ingestion of the viruses, and subsequently assaying the concentrations of viruses by inoculation of mosquito suspensions into tissue cultures. This work will be done in collaboration with Dr. Leon Rosen.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

4.0062, JAPANESE ENCEPHALITIS ON GUAM

R. DETELS, U.S. Dept. of Hlth. Ed. & Wel., P.H.S. Natl. Insts. of Health, *Bethesda, Maryland* 20014

Sera will be collected from Guamanians born prior to, during and after the occurrence of the 1947 epidemic and will be analyzed for antibody to JEV and other Group B and Group A arboviruses. Sera will also be collected for antibody screening from animals. Mosquitoes will be collected to determine the types of culicenes present on the island which might act as vectors.

Eighteen percent of sera from 498 Guamanians born since 1900 contain hemagglutination inhibition antibodies to JEV. Twenty-one percent born prior to 1950 and 8 percent born since 1950 have HI antibody to JEV suggesting that there has been Group B arbovirus activity on Guam since 1950. Nonetheless, only 1 of 100 pigs bled had HI antibody JEV. Culex tritaeniorhynchus, but not Culex annulus, has been identified on the island.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.

4.0063, BIONOMICS OF MARYLAND MOSQUITOES

W.E. BICKLEY, Univ. of Maryland, Agricultural Experiment Sta., *College Park, Maryland* (MD-H-073-A)

OBJECTIVE: Obtain information about the bionomics of mosquito fauna and to relate the information obtained to the control of pest mosquitoes and mosquitoes which may transmit eastern equine encephalitis.

APPROACH: In the immediate future the hatching response of eggs of Aedes sollicitans and other species will be studied in detail. Emphasis will also be placed on the biology of Culiseta melanura.

PROGRESS: Publication of results of the long-term study of Culiseta melanura occurred in 1969. Observations on the bionomics and distribution of several species of Aedes continued. Information on mosquito species that are relatively rare in Maryland is being collated and a manuscript is being prepared for publication. New distributional records involve A. tormentor, A. stimulans, A. punctor, A. stricticus, A. cinereus, A. excrucians, Psorophora discolor and Culiseta sylvestris minnesotae. In cooperation with the Walter Reed Army Institute of Research experiments were conducted using 3 laboratory strains of Anopheles stephensi. Differences in egg structure, fecundity, feeding behavior, susceptibility to malaria, and longevity were demonstrated. An intricate pattern of inter-strain fertility was demonstrated.

SUPPORTED BY Maryland State Government

4.0064, A STUDY IN INSECT TRANSMISSION OF ANAPLASMOSIS

H.F. MCCRORY, Delta Branch Experiment Sta., *Stoneville, Mississippi* 38776 (MIS-SUTL-II)

OBJECTIVE: Determine if susceptible animals in the presence of carrier animals, can be infected under field conditions with anaplasmosis when exposed to either day feeding or night feeding insects. Determine if the mosquito species, can transmit anaplasmosis under laboratory conditions.

APPROACH: One group of susceptible calves will be exposed to night feeding Diptera and one group to day feeding Diptera, Insect species will be used in studies on their potential to transmit anaplasmosis from carrier animals to susceptible animals.

PROGRESS: A three-year field study to determine the relative roles of the Culicidae and Tabanidae as vectors of anaplasmosis has been concluded. During the three-year study, 32% of the animals exposed to all insects contracted anaplasmosis, while none of the animals that were exposed to all insects except houseflies contracted the disease. The data from this study eliminated the mosquitoes from consideration as vectors of anaplasmosis. The data further incriminated the horseflies as important vectors in the spread of anaplasmosis. However, during the study, collection data indicated that another group of insects, the Hippelates, or eye gnats, should be considered as vectors of anaplasmosis in conjunction with the horseflies. The eye gnats feed on the blood from wounds produced by horseflies. Thus, the possibility exists that these flies could be vectors of anaplasmosis by first feeding at horsefly wounds on diseased animals and then feeding on horsefly wounds on susceptible animals.

SUPPORTED BY Mississippi State Government

4.0065, MOSQUITOES AS VECTORS OF LIVESTOCK DISEASES

R.H. ROBERTS, Delta Branch Experiment Sta., *Stoneville, Mississippi* 38776 (00-ENT-HO118-2505-00)

OBJECTIVE: Determine biology and ecology of mosquitoes and other possible insect vectors in relation to livestock disease, especially anaplasmosis; find efficient vector control measures.

APPROACH: Conduct studies to relate mosquito abundance to seasonal livestock disease peaks; evaluate control methods and determine effects of insect control practices on disease incidence; explore behavior, ecology, population dynamics of important vectors like mosquitoes.

PROGRESS: Light trap collections of mosquitoes both within and outside of a 4x4-mesh screened building were similar as to species and numbers caught between 6 pm. and 7 am. The most abundant species was Psorophora confinnis, followed by Anopheles quadrimaculatus and Aedes vexans. The numbers present are considered to be sufficiently high to transmit anaplasmosis if Culicidae are in fact transmitters of the disease. However, trials with splenectomized calves housed with animals in the acute stage of the disease were negative indicating mosquitoes to be poor vectors if at all.

SUPPORTED BY U.S. Dept. of Agriculture - A.R.S. - E.N.T

4.0066, WATER QUALITY REQUIREMENTS OF AQUATIC INSECTS

A.R. GAUFIN, Univ. of Montana, Undergraduate School, *Missoula, Montana* 59801 (14-12-438)

Description: The objectives of the work are to determine the dissolved oxygen, temperature and pH requirements of the 14 species of aquatic insects. These 14 species are distributed among five different families: (1) Ephemeroptera, (2) Plecoptera, (3) Odonata, (4) Trichoptera, and (5) Diptera. It is proposed that at the completion of this research, accurate estimations of the effects to be ascertained for each of the three factors over a range of concentrations, from lethal to that of no adverse effect, will be accomplished. Interpretable measures of effect shall be used rather than any change that is observed. Although growth and reproduction are the most sensitive and significant parameters of effect, conditions shall not allow their use, however, special effort shall be made to study egg production and survival whenever possible.

Lethal ranges for a short exposure shall be established for temperature and oxygen simultaneously during the initial months of the project. Thirty to ninety-day exposures during growth, molting, and food consumption shall be measured. Temperature is important, as pre- emergence is a hazard resulting from thermal discharges and warming of natural waters during the winter months.

SUPPORTED BY U.S. Environ. Protect. Agency - O.O.W.P.

4.0067, INSECTS AS VECTORS OF DISEASES OF MILITARY IMPORTANCE IN ETHIOPIA THEIR ECOLOGY AND CONTROL

M.L. SCHMIDT, U.S. Navy, Field Facility, *New York, New York* 09319

Map the distribution of diptera known or suspected to be human disease vectors, demonstrate infectious agents in wild-caught vectors, confirm vector capacities by experimental transmission with lab-reared insects, determine the seasonal incidence, biting behavior and breeding sites of species with high vector potential. Information is required to develop efficient procedures for protection of military personnel against disease.

Diptera will be collected from various areas of Ethiopia. Overlay maps will be prepared to demonstrate the relation of distribution to topography, climate, and disease prevalance. Mosquitoes will be referred to the Virology Division for isolation of arboviruses. Insects will also be examined for filariae and trypanosomes. Virus-vector relationships will be studied in lab-reared insects and will include determinations of infection thresholds, extrinsic incubation periods, virus grwoth and persistence curves, and transmission efficiencies.

Work has centered exclusively around simulium species and their role in transmission of onchoceriasis. Seasonal population density studies on S Damnosum in a lowland area endemic for onchocerciasis revealed a peak abundance in June, decreasing in August and September, and little activity during the dry season (November through May) - microdissections of nearly 2,500 flies revealed a maximum infection rate (1.75 percent) in August and September compared to 0.11 percent in June. Thus, maximum risk of infection occurs midway in the wet season.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0068, LABORATORY ANALYSIS OF INSECTICIDE EFFECTIVENESS AGAINST MEDICALLY IMPORTANT INSECTS

J.H. CROSS, U.S. Navy, Medical Research Unit 02, *Taipei, Republic of China*

Technical Objective: Initiate and maintain a surveillance for medically important insects which are resistant to the commonly used insecticides in south east asia. This information is required to guide insect vector control operations in combat areas.

SUPPORTED BY U.S. Dept. of Defense - Navy

4.0069, ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES)

G. FIELD, Univ. of Rhode Island, Agricultural Experiment Sta., *Kingston, Rhode Island* 02881 (RI00625)

OBJECTIVE: Determine the natural food of black fly larvae. Determine the effect of eutrophication of streams on the development of black fly larvae. Determine the faunistic relationships of black fly larvae. Establish a laboratory culture of simuliids.

APPROACH: Field studies: Locate streams in which simuliids occur. Determine parameters of the ecological system. Determine water quality. Laboratory studies: Determine adequate larval diet. Determine effects of eutrophication by nitrates and phosphates on larval dietary.

PROGRESS: A number of streams in Washington County has been surveyed and the greatest concentrations of simuliid larvae have been found in streams receiving mild organic pollution. Larvae of Simulium vittatum Zett. have been found to be abundant in a stream receiving discharge from a private fish hatchery. Large populations of chironomid larvae, isopods, and amphipods are also found in the same stream. Also, there is a large biomass of aquatic weeds which may be due to the increased productivity of the stream. Large numbers of black fly larvae have also been found in waters flowing from eutrophic ponds. Larvae of Simulium decorum Walk. have been found in large numbers in streams of this nature. Preparations are under way to determine chemical and physical parameters of streams supporting heavy populations of larvae. Tests for phosphate, nitrates, total solids have been worked out.

SUPPORTED BY U.S. Dept. of Agriculture - C.S.R.S.

4.0070, RESEARCH ON ARTHROPOD-BORNE DISEASES - I

J.W. WRIGHT, World Health Organization, *Geneva, Switzerland*

The programme of research being undertaken at WHO on Aedes aegypti and other Stegomyia mosquitos is related to the transmission of haemorrhagic fever and yellow fever. In the case of the former, a Research Unit has been established in Bangkok, Thailand, in which investigations are being undertaken on the ecology, biology and control of Ae. aegypti and closely related species with the objective of developing control procedures that would allow the long-term and emergency control of this disease. Ecological investigations are now far advanced and a large scale control programme has been started. In the case of yellow fever, WHO has established a Research Unit in Dar es Salaam, Tanzania, the objectives of which are as follows: (1) determination of the distribution, density and vectorial potential of Aedes aegypti in East Africa, (2) investigation of the occurrence and distribution of other Aedes (Stegomyia) species, particularly those of the subgenus Stegomyia, (3) study of the genetic relationships between the populations of Ae. aegypti and their differences in

465-868 O - 72 - 11

morphological characteristics and behaviour patterns, (4) study of the ecology of the various populations of Ae. aegypti and related Stegomyia species, and in particular to determine (a) the larval habitats, (b) the seasonal prevalance, and (c) the preferred hosts and times of biting in urban, rural and sylvan areas, (5) assessment of the insecticide susceptibility status of Ae. aegypti and related species, and of methods of chemical control, (6) search for other methods of control based on biological and autocidal processes, (7) investigation of the biting habits and vectorial potential of other species of Aedes. Investigations on items 1, 2, 3, 4 and 5 are now well advanced, studies will be initiated on item 7 in 1970 and on item 6 in 1971.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. -
H.S.M.H.A

4.0071, ENTOMOLOGY DEVELOPMENT OF A LIGHTWEIGHT TRAP FOR COLLECTION OF MOSQUITOES FOR VIRUS ISOLATION

V.J. TIPTON, U.S. Army, Brooke Gen. Hosp. & Med. Ctr., *San Antonio, Texas* 78234

Objective: Development of a lightweight trap for collection of mosquitoes for virus isolation.

Approach: CDC light trap for collecting mosquitoes has been modified in such a way as to combine the desirable features of this trap with those of the Shannon trap. Field testing will compare available traps which have the capability of collecting mosquitoes alive.

July 64 thru April 65 several modifications have been made to the prototype. Field tests have shown the MFSS trap to be superior to other traps available. However, further testing is necessary to determine the optimum size of the trap.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0072, ASSESSMENT OF THE IMPORTANCE OF FILARIASIS IN THAILAND

C. HARINASUTA, Mahidol University, *Bangkok, Thailand*

To study the prevalence and distribution of filariasis in Thailand and assess the public health importance of the infection. To gather sufficient data on the ecology of the infection to allow rational control measures to be formulated. This disease is not acquired in the U.S. and a study of the natural distribution of this infection in specific areas in Thailand cannot be done elsewhere. Information would have direct and important military usefulness if troops were to be placed in those areas of Thailand and may also have some applicability to situations in other areas.

Study the habits of the mosquito vectors and a search for animals of the area which may be naturally infested and act as reservoirs. The existence of an extensive animal reservoir could nullify control efforts based on mass treatment of the human population.

SUPPORTED BY U.S. Dept. of Defense - Army

4.0073, AQUATIC & SEMI-AQUATIC DIPTERA STUDIES

S.E. NEFF, Virginia Polytechnic Institute, Agricultural Experiment Sta., *Blacksburg, Virginia* 24061 (VA-0200074)

OBJECTIVE: Elucidate the ecology and ethology of this important but poorly known insect Order.

APPROACH: The immature stages of the families Ephydridae and Sciomyzidae are imcompletely described, and more information and material is needed for adequate descriptions. Species encountered are to receive thorough anatomical study, and descriptions of all stages will be prepared. Data concerning oviposition hatching, larval feeding behavior, pupation, adult emergence and mating are being collected. The effect of certain environmental factors on these activities will be studied. Promising predaceous or parasitoid species will be scrutinized as possible biological control agents against noxious plant and animal species.

PROGRESS: The life-history of Glyptotendipes (Demeijerea) atrimanus has been studied. Larvae burrow in the zooecium of Pectinatella magnifica and feed upon detritus circulated by the bryozoan. Pupae give rise to adults in 3 days after the pupa's formation and swim free of burrow. Taxonomic placement of Demeijerea in synonomy with Endochironomus is erroneous; Demeijerea is allied with Glyptotendipes and should be recognized as a valid subgenus within Glyptotendipes.

SUPPORTED BY Virginia State Government

4.0074, PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA

R.F. HARWOOD, Washington State University, Agricultural Experiment Sta., *Pullman, Washington* 99163 (WNP01998)

OBJECTIVE: Perfect laboratory rearing techniques under various light and temperature conditions; Establish criteria for recognizing adult diapause; Determine photoperiod and temperature conditions requisite for diapause; Under diapause determine cold and heat tolerance; Seek differences in temperature and photoperiod responses of latitudinally diverse strains.

APPROACH: Test rearing in photoperiod and temperature controlled cabinets; Diapause criteria assessed by examining ovarian and fat body condition of females; willingness to blood feed; fate of blood meals; Determine heat and cold survival in days for 50% survival (LT/50); Compare latitudinal strains.

PROGRESS: Strains of this mosquito originating from 200 miles N. of Edmonton, Alberta (50 N lat.), and central Washington (47 N) are under present investigation. The more northernly group responds to an eight hour photoperiod by developing a large fat body. Additional photoperiod tests are underway. Contacts have been made to obtain a more southern California strain (37 N) for comparison.

SUPPORTED BY Washington State Government - Olympia

4.0075, CALIFORNIA ENCEPHALITIS VIRUS IN WISCONSIN

W.H. THOMPSON, Univ. of Wisconsin, School of Medicine, *Madison, Wisconsin* 53706

This research involves surveillance and epidemiologic studies of California encephalitis, the most common arbovirus disease in Wisconsin and other upper midwestern states. Serologic and virus isolation studies will be conducted with diagnostic specimens received from physicians and pathologists. Clinical histories will be evaluated for spectrum of disease and possible sequelae. Serologic studies will be conducted in families of cases and in other special groups to learn more about the distribution of these infections. Although the LaCrosse strain so far associated with disease will be of main concern, comparative studies will be done with three or more other strains present in the area.

Epidemiologic studies will be conducted around rural and suburban homes where children have been infected. Serologic virus isolation and transmissions studies of small forest-dwelling mammals and insects will be used to search for virus reservoir and overwintering mechanisms. Sentinel rabbits will be employed to study the distribution of virus activity and to evaluate control measures centered on reduction of breeding sites of the main insect vector, Aedes triseriatus.

SUPPORTED BY U.S. Dept. of Hlth. Ed. & Wel. -
H.S.M.H.A

4C. FISH AND SHELLFISH

4.0076, RENOVATION OF TROUT STREAMS

C.E. HASTINGS, State Game & Fish Commission, *Atlanta, Georgia* 30334

Procedures: Portions of the following streams were selected for renovation: Dicks Creek (Tallulah River Watershed), Tuckaluge Creek, Blood Mountain Creek, Coleman River, Mill Creek (Tallulah River Watershed), Tate Branch, and Turkey Creek.

Dicks Creek, Tuckaluge Creek, Blood Mountain Creek, and Coleman River contain waterfalls which prohibit upstream fish movement. Mill Creek, Tate Branch, and Turkey Creek require construction of barriers before renovation. These streams will be renovated with rotenone or Antimycin A to eradicate existing fish populations. When feasible, trout will be saved for restocking by collecting with electrofishing gear prior to renovation.

Fish which are removed prior to and during renovation will be collected to gather information on standing crops, population dynamics, and life histories of the existing fish populations. Data which will be collected will include species of fish, numbers of fish, lengths of fish, and weights of fish. These data can be used to calculate length- weight relationships, condition factors, and standing crops. Scales will be collected to determine age-growth relationships. Digestive tracts will be collected to determine food habits. Bottom macrofauna samples will be collected prior to renovation. These data and the food habit data can be used to determine forage ratios. Blood Mountain Creek was selected to determine the ability of brook trout to become re- established in a stream in a severely damaged watershed due to logging. After renovation, the streams will be designated preservation streams for brook trout. They will not be stocked after establishment of fish populations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0077, LIFE HISTORY OF ST. JOE RIVER CUTTHROAT TROUT

J.F. KEATING, State Fish & Game Department, *Boise, Idaho*

Study Objectives: To study selected life history phases, distribution, and abundance of cutthroat trout and northern squawfish in the St. Joe River and tributaries in order to provide basic information needed to develop an improved trout management program. To measure and evaluate the physical and biotic habitat of the St. Joe River drainage as related to the production of fish, primarily cutthroat trout, to provide basic information needed to develop an improved trout management program. To assess the desirability of a proposed Squoxin (selective squawfish toxicant) treatment of the St. Joe River, to determine the need for, the extent and the timing of said treatment, and to establish before-and-after studies to evaluate the treatment.

Job Objectives: To collect and assess selected life history and ecology data on cuttroat trout in St. Joe River drainage, including status of populations prevailing growth rates, age and size at maturity, migration patterns, distribution, abundance, and factors affecting yield of juveniles in tributary streams. To determine if introduction of more fry or removal of predator- competitors from tributary streams results in increased numbers of juvenile cutthroat rearing in such streams.

Procedures: Beaver Creek, a typical tributary of the upper St. Joe drainage, will be divided into six sections with rotary drum screen weirs. Some sections will serve as controls with no fry added or fish removed. Other sections will be test units with fry added and/or predator-competitors removed. Evaluation of fry liberations or fish removals will be made by transect counts of fish rearing in sections plus enumeration of the number of fish which migrate from the section.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0078, POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS

J.C. BASS, State Forest. Fish & Game Com., *Pratt, Kansas* 67124

Objective: To determine the method or methods whereby the greatest quantity of catchable fish may be obtained from previously non- productive or marginally-productive strip-mine lakes in Southeast Kansas.

Procedures: 1. Quarterly analyses of pH, transparency, dissolved oxygen, ortho- and methaphosphate, nitrate, carbon dioxide, boiling- point acidity, total alkalinity, temperature (air and water), number of benthic organisms per square meter of bottom, and number of planktonic organisms per liter of original water sample will be effected on each of twelve strip-mine lakes. 2. The group of twelve strip-mine lakes represents a variety of chemical-physical and biological conditions, especially with respect to pH, planktonic and benthic organisms, and fish populations. Various lakes have been designated as control lakes, and others are designated as experimental lakes which have undergone management and/or development measures, including liming, waterlevel changes, fish population eradication and restocking. Lakes in these various categories will continue to be monitored. The fish populations will be studied in designated strip-mine lakes of this group, and standing crop, productivity, and growth-rate information determined. Specified lakes may undergo fish population eradication using approved toxicants under state-financed projects.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0079, A STUDY OF THE INTERACTION OF THREE SPECIES OF BULLHEAD AND ASSOCIATED GAME FISH SPECIES IN A SINGLE LAKE

D.E. OLSON, State Div. of Game & Fish, *Saint Paul, Minnesota* 55101

The objective is to determine intro- and inter-specific relationships of bullheads and associated game fish species and the effect of a known level of Bullhead population reduction on the population structure of the bullhead species and associated game species and on the quality and catch composition of the sport fishery.

The lake supports a fishery for walleye, largemouth bass, panfishes and northern pike and bullheads of the three species have always been present. Brown and black bullheads have been present in large enough numbers to warrant intermittent removal over the past 25 years. A lake survey in 1966 has indicated that there has been a recent sharp increase in the bullhead population and a decline in the game fish populations. Adult game fish are still present in good numbers but reproduction, especially among centrarchids, appears to have been poor in the past few years. With the background information on the lake, there is an opportunity to effect a known level of bullhead removal and evaluate its effect on both bullheads and associated game species and on the sport fishery. While considerable information is available on bullhead life histories, specific information is lacking on the interrelationships between the species and between bullheads and associated game species. Information on these relationships is needed to properly evaluate the effects of bullhead removal.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0080, FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES

C.J. BROWN, Montana State University, Agricultural Experiment Sta., *Bozeman, Montana* 59715 (MONB00410)

OBJECTIVE: To supply basic biological information on fish as a foundation for species management. To secure needed information on fish habitat in order to maintain, augment and improve the habitat. To cooperate with other agencies in the dissemination of useful knowledge for proper fisheries management.

APPROACH: Life history investigations of unstudied species by observation and rearing. Species relationship - compatability, space requirements - by experimentation. Food relationship; food production through stomach analyses and population studies. Ranch pond production under different stocking densities - species combination, etc. Continue to plot species distribution by making additional collections in unstudied areas. Fish host-parasite relations by histological and physiological techniques. Behavior studies by marking and tracking techniques.

PROGRESS: Projects Completed: 1. Life history, habitat and distribution of the lake sturgeon Acipenser fulvescens in the South Saskatchewan River, Alberta. 2. Comparative morphology and host- parasite studies of Trichophora clarki (N. Sp.) on cutthroat trout (Salmo clarki). 3. Movement and homing of cutthroat trout (Salmo clarki) in Bridge and Clear Creeks, Yellowstone National Park. 4. The distribution of sculpins in Montana.

Projects in Progress: 1. Handbook of Montana Fishes. 2. Open- water tracking of cutthroat trout (field work complete). 3. Homing behavior of mountain whitefish. 4. Population dynamics of stream aquatic insects. 5. The distribution of stoneflies in the Yellowstone River in relation to bottom types, turbidity, temperature and chemistry. 6. The distribution of the northern redbelly dace and fine scale dace in Montana (nearly complete).

4. AQUATIC PEST ECOSYSTEMS

SUPPORTED BY Montana State Government - Helena

4.0081, GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE

D.B. JESTER, New Mexico State University, Agricultural Experiment Sta., *Las Cruces, New Mexico* 88070 (NM00040-SP)

OBJECTIVE: Determine the spawning success of principal game fish species in order to evaluate the effect of fluctuations of reservoir water level. Determine population structure and movements of principal rough fish species in order to determine rough fish control. Evaluate and compare an experimental rough fish trap and a commercial fishing operation as means of rough fish control.

APPROACH: A series of nets will be set in areas where spawning of principal game fish species should occur. Fish will be examined for eggs, sperm, and flacidity. These data will be used to determine when and where spawning occurs. Water levels and temperatures on spawning beds will be recorded. A series of nets, traps, and stations, will be set to determine population structure and movements of rough fish in the lake. Records of species, numbers and weights of rough fish species removed by commercial fishermen will be maintained.

PROGRESS: Evaluation of rough-fish management in Elephant Butte Lake - including introduction of predators, commercial harvest, and control of water level shows increase from 20 to 48% game fish by weight in 3 years followed by level-off at 45% for 3 years. Age-growth, length-weight relationships, and condition studies on buffalo, carp, and river carpsucker shows production to sustain commercial fishing for resource utilization and enhance sport fishing. Commerical fishing reduced buffalo by 110,000 fish in 5 years. Reduced competition allowed 30,000 increase in river carpsucker in littoral. Introduced walleye and white bass eat 94% and 78% gizzard shad. Shad catch declined from 4.9 to 2.0/net-unit in 4 years. Age-growth in 1965 and 1969 show partial relief from stunting. Forage for game fish is highest use of shad. Introduction of northern pike and striped bass recommended for additional utilization of shad. Hoop, trap, and colored gill nets tested as commercial harvest methods. Neither hoops nor traps were efficient baited or unbaited. Clear monofilament promising. Limnological data contain valuable information pertaining to life histories and ecologies of rough-fish species. Cyanide appeared in the lake in 1969, 3 years after mine effluent spill 400 miles upstream. Coliform bacteria counts correlated with contact sports.

SUPPORTED BY New Mexico State Government

4.0082, LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN

T.M. JOLLIFF, State Dept. of Env. Conserv., *Cape Vincent, New York*

Objectives: To continue development of an interim comprehensive fisheries management plan for Lake Ontario, to serve as a baseline or guideline for research and management activities.

Procedures: Planning will continue the work of the period January 1, 1971 thru March 31, 1971. The comprehensive plan will encompass historical factors such as the former abundance of fisheries, their decline, the deterioration of the environment, present problems, and managerial and research methods needed to meet present and future challenges.

The comprehensive plan will serve as a tool for the enhancement of both commercial and sport fisheries and related or associated activities. Factors which will be included in the overall plan are as follows: Development and management of previously abundance species of fish, management of present species, and introduction and management of new species. Environmental control involving pollution, water levels, etc., together with associated limnological studies all aimed at the preservation of fisheries and related activities. Compilation of catch and fishing effort statistics. Research on fish stocks, population dynamics and regulation of catch. Coordination of multi-agency activities, and computerization of inventory data. The place of fish culture in future fishery management in Lake Ontario. Special pesticide studies to permit utilization of fish flesh. Planning in terms of lake areas, geographical, estuarine, tributary, inshore and deep water factors, and population center locations.

Information will be taken from historical writings and the literature in general, available data on the lake, and previously written plans for Lake Ontario. Plans will be made in collaboration with other agencies, governmental and private, state, provincial and federal, educational and institutional.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0083, REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES

J.H. RAYNER, State Fish Commission, *Portland, Oregon* 97201

P.S. Objectives: To determine the reproductive biology and early life history of the cyprinid species in East and Paulina Lakes.

Job Objectives: 1. To collect net samples and make direct observations of spawning fish in both lakes. 2. To artificially incubate chub eggs to observe egg development and early life history as related to water temperature.

Procedures: Reproductive activity will be monitored through direct observation on the spawning site. Each lake will have a constant temperature recording unit at or near a spawning site. Spawning will be correlated with water temperature. Sex ratios on the spawning site will be determined by sampling an entire spawning population. This will be done through the use of circular throw-nets, rotenone or Fintrol. Fecundity, as a means of determining reproductive capabilities, will be determine by counting the eggs per female of a representative sample. Egg deposition patterns on the spawning site will be determined by sampling at the spawning site. The spawning sites will be mapped to try to determine all possible spawning areas.

The egg development period will be determind by observing development under both artificial and natural conditions. The artificial incubation system will utilize lake water under as close to normal conditions as can be maintained. The incubation water temperature will be monitored to correlate it with the lake temperature under natural conditions. Dissolved oxygen and alkalinity will be determined on a daily basis. Samples of the developing fish will be studied for developmental characters. Egg development under natural conditions will be monitored by observing and sampling the eggs from an enclosed spawning site. This site will have a constant temperature unit for monitoring water temperatures. Dissolved oxygen and alkalinity will also be determined daily throughout the development period. These data from the natural site will be correlated with the artificial incubation data.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0084, NORTHERN PIKE LIFE HISTORY STUDY

W.P. RUTLEDGE, State Parks & Wildlife Dept., *Austin, Texas* 78701

Objective: To determine for Northern pike in Texas waters.

Procedures: 1. Northern pike captured by various sampling devices will be sacrificed and their stomach contents analyzed. 2. During spawning season, an extensive effort will be made to gather all types of reproductive data on Northern pike. 3. Movements of Northern pike throughout the year will be monitored with a tagging program. Scales and vertebrates will be collected. Age and growth information will be determined from these. 4. All specimens will be grossly examined for external parasites. Sacrificed specimens will be examined for internal parasites. 5. Literature review will be conducted.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0085, WALLEYE LIFE HISTORY STUDY

W.P. RUTLEDGE, State Parks & Wildlife Dept., *Austin, Texas* 78701

Objective: To determine for Northern pike in Texas waters.

Procedures: 1. Walleye captured by various sampling devices will be sacrificed and their stomach contents analyzed. 2. During spawning season, an extensive effort will be made to gather all types of reproductive data on walleye. 3. Movement of walleye throughout the year will be monitored with a tagging program. Scales and opercle bones will be collected. Age and growth information will be determined from these. 4. All specimens will be grossly examined for external parasites. Sacrificed specimens will be examined for internal parasites. 5. Literature review will be conducted.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

4.0086, SURVEYS FOR PANFISH CONTROL STUDIES

T. BEARD, State Dept. of Nat. Resources, *Madison*, *Wisconsin* 53701

Objectives: To survey and eventually select small bodies of water for new study areas. To initiate preliminary research which is essential to an understanding of slow-growing panfish problems.

Procedures: A literature review relating to panfish will be completed under the following general headings: (1) Population dynamics, (2) Environmental characteristics, (3) Population control and (4) Early life history. With guidance from Fish Management personnel, survey will be made on selected lakes characterized by fast- and slow- growing panfish, from which lakes will be selected for subsequent studies on panfish control. A detailed study proposal concerning the factors affecting the early life history of bluegills will be completed. A preliminary study of perch early life history will be made. Assistance will be given Fish Management personnel in investigations concerning slow-growing panfish and observations will be made of chemical reclamation operations.

SUPPORTED BY U.S. Dept. of Interior - Bu. Sport Fish.

SUBJECT INDEX

Absorption and Translocation

Animal Pests

Oral

THE UPTAKE OF AND BIOLOGICAL RESPONSES TO AROCLORS IN CHANNEL CATFISH ...1.0267

Foliar

FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095
EXPANDED AQUATIC PLANT CONTROL PROJECT ...2.0146

Plant -other

CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025
FATE OF INSECTICIDES IN SOIL AND THEIR MOVEMENT IN WATER AND CROPS ...1.0111
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319
EXPANDED AQUATIC PLANT CONTROL PROJECT ...2.0146
METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186

Root

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019
HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...1.0035
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
EXPANDED AQUATIC PLANT CONTROL PROJECT ...2.0146

Accumulation Rates -pesticides

Environment Accumulation Rates

WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...1.0005
PESTICIDE RESIDUES ON ARIZONA CROPS ...1.0007
EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010
REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...1.0021
DISPOSITION OF PESTICIDES IN THE SOIL ...1.0031
PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...1.0032
HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...1.0035
REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...1.0047
CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...1.0051
PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...1.0052
BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053
CONTROL OF PESTICIDES IN SOIL AND WATER ...1.0054
PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS ...1.0055
PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES ...1.0062
PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS ...1.0063
AN EVALUATION OF THE INSECTICIDE 'SEVIN' AS A WATERSHED POLLUTANT ...1.0067
MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...1.0071
FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095
MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...1.0098
MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099
IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD ...1.0123
EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133
PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...1.0143
THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0144
RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146
GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152
PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...1.0170
SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...1.0181
CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...1.0189
TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE ...1.0201
OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...1.0219
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0223
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0224
THE CHEMISTRY AND TOXICOLOGY OF AGRICULTURAL CHEMICALS ...1.0322
IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS ...1.0335
ENVIRONMENTAL TOXICOLOGY OF PESTICIDES ...1.0361
CHEMICAL BIOCIDES IN LAKES ...1.0364
THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...1.0365
AQUATIC PLANT CONTROL ...2.0128
THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...2.0150
RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...2.0161

Tissue Accumulation Rates

PESTICIDE RESIDUES ON ARIZONA CROPS ...1.0007
THE CYCLING OF CL-36 LABELED DDT IN NATURAL ECOSYSTEMS ...1.0078

FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095
HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...1.0107
METABOLISM OF ENDRIN IN PONDS ...1.0113
LIMNOLOGICAL FACTORS AFFECTING PESTICIDE RESIDUES IN SURFACE WATERS ...1.0149
RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION ...1.0194
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0228
EFFECT OF ENDRIN ON EGG-SPERM FORMATION AND EMBRYONIC DEVELOPMENT ...1.0229
RELATIONSHIPS BETWEEN SUB-LETHAL PESTICIDES AND REPRODUCTION AND BEHAVIOR OF FISHES ...1.0245
CONTAMINATION OF CHANNEL CATFISH WITH DIELDRIN FROM AGRICULTURAL RUNOFF ...1.0247
BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH ...1.0261
CHRONIC EFFECTS OF DURSBAN ON WARM-WATER FISH ...1.0282
EARLY SQUAMATION OF BLUEGILL (LEPOMIS MACROCHIRUS) AND FATHEAD MINNOWS (PIMEPHALES PROMELAS) EXPOSED TO AROCLORS ...1.0286
CHRONIC TOXICITY OF PESTICIDES TO FISH ...1.0287
PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0288
UPTAKE AND METABOLISM BY FISH OF 2,4-D DIMETHYL AMINE SALT ...1.0293
RESIDUES OF TFM IN FISH--LA CROSSE ...1.0315
IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS ...1.0335
MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS ...1.0338
TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...1.0344
SELECTED PESTICIDES IN AQUATIC FUNGI IN THE THREE RIVERS AREA ...1.0345
POND ECOLOGY AND PRODUCTION AS AFFECTED BY SIMAZINE ...1.0353
PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...1.0358
THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...1.0365
THE EFFECTS OF ANTIMYCIN A ON THE METABOLISM OF SELECTED TISSUES IN FISH (ABBREV) ...2.0262

Acetone

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086

Acids -nonspecific

ORGANIC SUBSTANCES IN WATER ...1.0119
ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...1.0153

Acoustics

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...2.0096

Acriflavine

MULTIPLICATION OF ENTERIC VIRUSES IN SHELLFISH ...3.0069

Adenosine Triphosphate

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260
THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM ...1.0350

Adenylic Acid

THE NUTRITION AND BEHAVIOR OF MOSQUITOES ...4.0033

Adsorption

ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211

Air Environment

ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...4.0007

Air Pollution

VOLATILIZATION LOSSES OF PESTICIDES FROM SOILS ...1.0016
REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0037
REDUCTION OF PESTICIDE RESIDUE HAZARDS ...1.0040
REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0046
WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...1.0050
IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD ...1.0123
ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN ...1.0132
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0140
STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES ...1.0142
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0158
CENTER FOR STUDY OF THE HUMAN ENVIRONMENT ...1.0190
DDT IN SNOW FALLEN AT HIGH ALTITUDE SINCE 1950 ...1.0214
PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES ...1.0306
ENVIRONMENTAL TOXICOLOGY OF PESTICIDES ...1.0361
SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...2.0028

Alabama

IDENTIFICATION OF PARASITES AND DISEASES EFFECTING MARICULTURE SPECIES ...3.0037

Alaska

DDT IN SNOW FALLEN AT HIGH ALTITUDE SINCE 1950 ...1.0214
EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...2.0002

Alcohols

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086
ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...1.0153
DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183
DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...1.0184

Aldehydes

SOILS, PESTICIDES, AND THE QUALITY OF WATER ...1.0103

ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

Algae - Chlorophyta

Charophyceae

Chara

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...2.0096

CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101

THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...2.0130

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024

Charophyceae

MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...2.0019

Chlorophyceae

Chlorella

CONTROL OF AQUATIC WEEDS BY USE OF N2-CO2-HE LASER SYSTEMS ...2.0091

Chlorophyceae -nonspecific

TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...2.0007

IDENTIFICATION AND CHARACTERIZATION OF MOSQUITO PATHOGENS ...2.0020

Chlorophyceae -other

A STUDY OF INHIBITORY COMPOUNDS PRODUCED BY FRESH-WATER ALGAE ...2.0138

STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...4.0022

Cladophora

PESTICIDE RESIDUES ON ARIZONA CROPS ...1.0007

CONTROL OF AQUATIC WEEDS BY USE OF N2-CO2-HE LASER SYSTEMS ...2.0091

CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101

Chlorophyta

MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...2.0019

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174

FIELD INVESTIGATION OF THE SUBMERSED AQUATIC ENVIRONMENT ...4.0003

Algae - Chrysophyta

Bacillariophyceae

MICROBIOLOGY OF FARM PONDS ...1.0220

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174

Chrysophyceae

Ochromonas

EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...2.0165

Algae - Cyanophyta

THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM ...1.0350

INTERCEPTION AND DEGRADATION OF PESTICIDES BY AQUATIC ALGAE ...1.0363

TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...2.0007

MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...2.0019

IDENTIFICATION AND CHARACTERIZATION OF MOSQUITO PATHOGENS ...2.0020

DEVELOP A SELECTIVE ALGACIDE TO CONTROL NUISANCE ALGAL GROWTH ...2.0151

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174

FIELD INVESTIGATION OF THE SUBMERSED AQUATIC ENVIRONMENT ...4.0003

ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...4.0007

Cyanophyceae

Anabaena

LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...2.0184

Chroococcaceae

DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...2.0094

LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...2.0184

Oscillatoria

DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...2.0094

Cyanophyta -other

DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...2.0094

STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...4.0022

Algae - Rhodophyta

Chondrus

STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...4.0022

Algae -nonspecific

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019

PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS ...1.0055

GREEN BAY RESEARCH PROGRAM ...1.0112

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...1.0143

ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...1.0326

THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0330

AN INVESTIGATION OF THE EFFECTS OF DDT AND OTHER CHLORINATED HYDROCARBONS ON THE GROWTH OF EURYHALINE MICROALGAE ...1.0336

ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...1.0339

INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0351

BIODEGRADATION OF PESTICIDES IN A FRESHWATER ECOSYSTEM - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0352

STUDY ON THE EFFECTS OF FISH TOXICANTS ANTIMYCIN A AND ROTENONE ON POND COMMUNITIES ...1.0366

MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...2.0062

DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...2.0094

INFLUENCE OF PESTICIDES & OTHER HYDROCARBONS ON GROWTH OF EURYTOLERANT MICROALGAE ...2.0148

ALGAE CONTROL BY ARTIFICIAL MIXING IN LAKE COCHITUATE ...2.0149

THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...2.0150

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168

EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...2.0170

EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...2.0171

SUBJECT INDEX

Algae -nonspecific

EUTROPHICATION - PILOT OPERATIONS ...2.0172
NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180
MARINE FISHERIES - SYMBIOSIS AND PARASITISM - RESEARCH ...3.0055
THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER ...4.0004
EUTROPHICATION OF IOWA LAKES AND STREAMS ...4.0008
OCCURRENCE OF FILAMENTOUS SLIMES ORGANISMS BELOW OUTFALLS ...4.0009
AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...4.0011
NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...4.0015
A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...4.0018
RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...4.0019
A PROPOSAL TO STUDY PHOSPHATE INDUCED ALGAL GROWTH IN ORDER TO SUPPRESS OR ELIMINATE THIS PHENOMENA ...4.0021
EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...4.0023

Algal Physiology

Environment

ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...1.0326
AQUATIC PEST CONTROL ...2.0112
INFLUENCE OF PESTICIDES & OTHER HYDROCARBONS ON GROWTH OF EURYTOLERANT MICROALGAE ...2.0148
EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...2.0165
EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168
EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...2.0171
NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180
ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...4.0007
EUTROPHICATION OF IOWA LAKES AND STREAMS ...4.0008
AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...4.0011
EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...4.0023

Growth and Differentiation

AN INVESTIGATION OF THE EFFECTS OF DDT AND OTHER CHLORINATED HYDROCARBONS ON THE GROWTH OF EURYHALINE MICROALGAE ...1.0336
INFLUENCE OF PESTICIDES & OTHER HYDROCARBONS ON GROWTH OF EURYTOLERANT MICROALGAE ...2.0148
EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...2.0165
INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...4.0001
A PROPOSAL TO STUDY PHOSPHATE INDUCED ALGAL GROWTH IN ORDER TO SUPPRESS OR ELIMINATE THIS PHENOMENA ...4.0021
STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...4.0022

Metabolism

Chemicals -algacides

AN INVESTIGATION OF THE EFFECTS OF DDT AND OTHER CHLORINATED HYDROCARBONS ON THE GROWTH OF EURYHALINE MICROALGAE ...1.0336
TOXICOLOGY OF PESTICIDES IN THE ENVIRONMENT ...1.0360
INTERCEPTION AND DEGRADATION OF PESTICIDES BY AQUATIC ALGAE ...1.0363
INFLUENCE OF PESTICIDES & OTHER HYDROCARBONS ON GROWTH OF EURYTOLERANT MICROALGAE ...2.0148
STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...4.0022

Enzymes

LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...2.0184

Nitrogen Fixation

GREEN BAY RESEARCH PROGRAM ...1.0112

Nutrition Studies

AQUATIC PEST CONTROL ...2.0112
THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174
NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180
FIELD INVESTIGATION OF THE SUBMERSED AQUATIC ENVIRONMENT ...4.0003
AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...4.0011
PHYTOPLANKTON NUTRITION AND PHOTOSYNTHESIS IN EUTROPHIC LAKES ...4.0016
A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...4.0018
RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...4.0019

Protein

A STUDY OF INHIBITORY COMPOUNDS PRODUCED BY FRESH-WATER ALGAE ...2.0138

Respiration

ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...4.0007

Pathological Physiology

A CRITICAL TEST OF METHODS FOR ISOLATION OF VIRUSES FOR USE IN CONTROL OF NUISANCE ALGAE ...2.0133

Photosynthesis

AN INVESTIGATION OF THE EFFECTS OF DDT AND OTHER CHLORINATED HYDROCARBONS ON THE GROWTH OF EURYHALINE MICROALGAE ...1.0336
THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM ...1.0350
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082
PHYTOPLANKTON NUTRITION AND PHOTOSYNTHESIS IN EUTROPHIC LAKES ...4.0016

Reproductive Physiology

STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...4.0022

Alkali Metals

Potassium

PROPERTIES OF TILE DRAINAGE WATER ...1.0045
TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...1.0056
PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269
SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0273
DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...2.0094
THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...2.0252
THE EFFECTS OF THANITE ON THE INORGANIC BLOOD CHEMISTRIES OF FISHES ...2.0253
MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...3.0106
THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0020

Sodium

- PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0006
- PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013
- TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...1.0056
- PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260
- PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269
- SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0273
- STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...2.0159
- THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...2.0252
- THE EFFECTS OF THANITE ON THE INORGANIC BLOOD CHEMISTRIES OF FISHES ...2.0253
- MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...3.0106

Alkaline Earths

Calcium

- PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0006
- PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013
- BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081
- MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082
- EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155
- PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269
- SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0273
- MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...1.0292
- BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...1.0303
- GROWTH REGULATORS AND MINERAL NUTRITION IN AQUATIC PLANT CONTROL ...2.0134
- THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...2.0252
- THE EFFECTS OF THANITE ON THE INORGANIC BLOOD CHEMISTRIES OF FISHES ...2.0253
- MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...3.0106
- THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0014

Magnesium

- PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0006
- MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...1.0266
- PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269
- MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...1.0292
- STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...2.0159
- THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...2.0252
- THE EFFECTS OF THANITE ON THE INORGANIC BLOOD CHEMISTRIES OF FISHES ...2.0253

Alkaline Soil -see Saline Soil

- OCCURRENCE AND BIONOMICS OF BLOODSUCKING MIDGES (DIPTERA: CERATOPOGONIDAE) IN IOWA ...4.0056

Alkaloids

- BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057

Alternative Planning

- GREEN BAY RESEARCH PROGRAM ...1.0112

Amide

- SOILS, PESTICIDES, AND THE QUALITY OF WATER ...1.0103

Amines

- SOILS, PESTICIDES, AND THE QUALITY OF WATER ...1.0103
- ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...1.0153

Acetylcholine

- COMPARISON OF METHODS USED TO MEASURE ESTERASE ACTIVITY. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...1.0274
- MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...1.0292

Aminobutyric Acid

- DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...4.0051

Catecholamines

- PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260
- IN VIVO AND IN VITRO STUDIES ON THE MODE OF ACTION OF TFM ...2.0250

Amino Acids

- PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269
- SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0273
- PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...1.0289
- PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...1.0290
- BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...1.0303
- GROWTH REGULATORS AND MINERAL NUTRITION IN AQUATIC PLANT CONTROL ...2.0134
- EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...2.0165
- THE NUTRITION AND BEHAVIOR OF MOSQUITOES ...4.0033

Creatine

- SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0273

Leucine

- CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025

Tryptophane

- RESIDUES OF TFM IN FISH--LA CROSSE ...1.0315

Amphibians

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...**1.0019**
FACTORS AFFECTING PESTICIDE TOXICITY ...**1.0255**
DISTRIBUTION AND ECOLOGY OF PENNSYLVANIA SALAMANDERS ...**2.0080**
DEVELOPMENT OF METHODS FOR COMMERCIAL PRODUCTION OF FROG LEGS FROM TADPOLES OF THE BULLFROG ...**3.0028**

Mutabilia

DISTRIBUTION AND ECOLOGY OF PENNSYLVANIA SALAMANDERS ...**2.0080**

Rana

MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...**2.0060**
DEVELOPMENT OF METHODS FOR COMMERCIAL PRODUCTION OF FROG LEGS FROM TADPOLES OF THE BULLFROG ...**3.0028**

Anesthesia

EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...**2.0234**

Animal Characteristics

Adaptation

BIOLOGICAL CONTROL OF WEEDS ...**2.0099**

Age

STREAM STUDIES TO DETERMINE TOXIC EFFECTS OF METHOXYCHLOR IN FISH POPULATIONS ...**1.0263**
GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...**2.0034**
MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...**2.0124**
SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...**2.0206**
SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...**2.0207**
SEA LAMPREY CONTROL - ASSESSMENT METHODS ...**2.0208**
BIOLOGY OF THE LARVAL SEA LAMPREY ...**2.0210**
SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...**2.0279**
EVALUATION OF THE INFLUENCE OF AGE AND SIZE OF CHANNEL CATFISH ON THE INFECTIVITY OF CCV ...**3.0006**
SUSCEPTIBILITY OF VARIOUS AGES OF FISH TO INFECTION ...**3.0063**
USE OF TISSUE SECTIONING TECHNIQUES TO ATTEMPT TO FOLLOW THE LIFE HISTORY OF WHIRLING DISEASE PARASITES FROM THE FIRST DAY OF INFECTION ...**3.0065**
CORRELATE NITROGEN GAS CONTENT OF WATER SUPPLIES WITH DISEASE ...**3.0088**
NORTHERN PIKE LIFE HISTORY STUDY ...**4.0084**
WALLEYE LIFE HISTORY STUDY ...**4.0085**

Environmental Response

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...**1.0249**
THE RELATIONSHIP OF TEMPERATURE TO DISEASE OF SALMONID FISHES ...**3.0051**
EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...**3.0119**

Fertility

FIELD STUDIES OF PESTICIDE EFFECTS ON FISHES ...**1.0257**
STREAM STUDIES TO DETERMINE TOXIC EFFECTS OF METHOXYCHLOR IN FISH POPULATIONS ...**1.0263**
MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...**2.0124**
ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...**4.0039**
BIONOMICS OF MARYLAND MOSQUITOES ...**4.0063**

Growth Rate

EFFECTS OF PESTICIDES ON MARINE ANIMALS ...**1.0244**
EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...**1.0249**
LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES ...**1.0258**
BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH ...**1.0261**
CHRONIC EFFECTS OF DURSBAN ON WARM-WATER FISH ...**1.0282**
EFFECTS OF PARATHION AND MALATHION ON WARM-WATER FISH PONDS ...**1.0283**
METHOXYCHLOR-CAUSED EFFECTS ON CUTTHROAT TROUT PHYSIOLOGY - CHRONIC TOXICITY OF INSECTICIDES TO COLD-WATER FISH ...**1.0296**
EFFECTS OF TOXICANTS UPON FISH MOVEMENT PATTERNS ...**1.0308**
SUBLETHAL AMOUNTS OF ORGANIC INSECTICIDES AND FISH ...**1.0313**
POND ECOLOGY AND PRODUCTION AS AFFECTED BY SIMAZINE ...**1.0353**
PHARMACOLOGICAL AND ECOLOGICAL EFFECTS OF PESTICIDES ...**1.0362**
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE I ...**2.0073**
MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...**2.0124**
ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...**2.0202**
SEA LAMPREY CONTROL - LAKE MICHIGAN CHEMICAL CONTROL ...**2.0203**
SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...**2.0206**
SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...**2.0207**
BIOLOGY OF THE LARVAL SEA LAMPREY ...**2.0210**
AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO ...**2.0227**
POPULATION DYNAMICS - LAKE TROUT ...**2.0235**
IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...**3.0018**
DEVELOPMENT OF METHODS FOR COMMERCIAL PRODUCTION OF FROG LEGS FROM TADPOLES OF THE BULLFROG ...**3.0028**
AQUICULTURE, SALMON CULTURE - RESEARCH ...**3.0053**
MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...**3.0056**
MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...**3.0060**
SALT WATER POND RESEARCH ...**3.0073**
SPAWNING AND REARING OF MARINE FISH ...**3.0110**
EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...**3.0119**
LAKE SUPERIOR PERIPHYTON IN RELATION TO WATER QUALITY ...**4.0017**
POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...**4.0078**
SURVEYS FOR PANFISH CONTROL STUDIES ...**4.0086**

Hatchability

EFFECT OF ENDRIN ON EGG-SPERM FORMATION AND EMBRYONIC DEVELOPMENT ...**1.0229**
STREAM STUDIES TO DETERMINE TOXIC EFFECTS OF METHOXYCHLOR IN FISH POPULATIONS ...**1.0263**
INVESTIGATIONS OF PHEROMONES AS CHEMOSTERILANTS FOR INSECTS WITH SPECIAL REFERENCE TO SYNTHETIC QUEN SUBSTANCE AND ITS ANALOGUES ...**2.0021**

CONTROL OF BLACK FLIES AND MOSQUITOES IN MAINE ...**2.0046**

BIOLOGY AND CONTROL OF TERRESTRIAL MOLLUSCS ...**2.0281**

Longevity

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...**1.0249**

RADIATION CYTOGENETICS OF THE YELLOW-FEVER MOSQUITO, AEDES AEGYPTI ...**2.0036**

BIONOMICS OF MARYLAND MOSQUITOES ...**4.0063**

Maturity & Growth Stages

EFFECT OF ENDRIN ON EGG-SPERM FORMATION AND EMBRYONIC DEVELOPMENT ...**1.0229**

CONTAMINATION OF CHANNEL CATFISH WITH DIELDRIN FROM AGRICULTURAL RUNOFF ...**1.0247**

THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...**1.0253**

RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...**1.0256**

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0269**

ACCUMULATION OF PESTICIDES IN MENHADEN ...**1.0299**

NEW INSECTICIDES & TECHNIQUES FOR PEST CONTROL ...**2.0016**

INVESTIGATIONS OF PHEROMONES AS CHEMOSTERILANTS FOR INSECTS WITH SPECIAL REFERENCE TO SYNTHETIC QUEN SUBSTANCE AND ITS ANALOGUES ...**2.0021**

SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...**2.0055**

STRIPED BASS STUDIES ...**2.0193**

ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...**2.0202**

LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...**2.0205**

SEA LAMPREY CONTROL - ASSESSMENT METHODS ...**2.0208**

BIOLOGY OF THE LARVAL SEA LAMPREY ...**2.0210**

INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...**2.0280**

BIOLOGICAL STUDIES OF MALACOPHAGOUS DIPTERA ...**2.0282**

CHANNEL CATFISH VIRUS REPLICATION CURVES IN INTERNAL ORGANS AND ASSOCIATED PATHOLOGY ...**3.0010**

DEVELOPMENT OF METHODS FOR COMMERCIAL PRODUCTION OF FROG LEGS FROM TADPOLES OF THE BULLFROG ...**3.0028**

REFINEMENT OF MANAGEMENT TECHNIQUES FOR STREAM TROUT LAKES ...**3.0035**

INFECTIOUS DISEASES OF SALMONID FISHES ...**3.0049**

ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...**3.0052**

MARINE FISHERIES - SYMBIOSIS AND PARASITISM - RESEARCH ...**3.0055**

TRANSMISSION OF ANAPLASMOSIS ...**4.0032**

MOSQUITOES OF MIDDLE AMERICA ...**4.0038**

POPULATION DYNAMICS OF MOSQUITOES IN FLORIDA ...**4.0048**

Metabolic Efficiency

DEVELOPMENT OF METHODS FOR COMMERCIAL PRODUCTION OF FROG LEGS FROM TADPOLES OF THE BULLFROG ...**3.0028**

Metabolism -other

PHARMACOLOGICAL AND ECOLOGICAL EFFECTS OF PESTICIDES ...**1.0362**

Mortality Rates

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...**1.0039**

EFFECT OF ENDRIN ON EGG-SPERM FORMATION AND EMBRYONIC DEVELOPMENT ...**1.0229**

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...**1.0249**

THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...**1.0253**

LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES ...**1.0258**

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...**1.0260**

LABORATORY BIOASSAYS TO DETERMINE TOXIC EFFECS OF METHOXYCHLOR IN FISH ...**1.0264**

CHRONIC EFFECTS OF DURSBAN ON WARM-WATER FISH ...**1.0282**

METHOXYCHLOR-CAUSED EFFECTS ON CUTTHROAT TROUT PHYSIOLOGY - CHRONIC TOXICITY OF INSECTICIDES TO COLD-WATER FISH ...**1.0296**

THE EFFECT OF DIELDRIN ON SURVIVAL AND DEVELOPMENT OF FISH EGGS ...**1.0300**

ELIMINATE OR REDUCE EFFECTS OF PESTICIDE RESIDUES ...**1.0311**

PESTICIDES AND WILDLIFE ...**1.0324**

GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...**2.0034**

CONTROL OF BLACK FLIES AND MOSQUITOES IN MAINE ...**2.0046**

BIOLOGICAL AND BIOCHEMICAL FACTORS INFLUENCING THE DEVELOPMENT OF LARVAL MOSQUITO POPULATIONS ...**2.0052**

MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...**2.0124**

ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...**2.0202**

RELATION OF LAMPREY EELS TO EXISTING SALMONID STOCKS IN CAYUGA LAKE ...**2.0219**

PISCICIDE TOXICOLOGY OF THE CYPRINIDS IN EAST AND WEST PAULINA LAKES ...**2.0228**

POPULATION DYNAMICS - LAKE TROUT ...**2.0235**

ESTABLISH MINIMUM DOSES OF ANTIMYCIN AND ROTENONE NEEDED FOR TOTAL KILLS OF TARGET FISHES ...**2.0247**

BIOLOGY AND CONTROL OF SNAILS ...**2.0268**

BIOLOGY AND BIOLOGICAL CONTROL OF SCHISTOSOMIASIS ...**2.0277**

IDENTIFICATION OF PARASITIC BACTERIAL FORMS ...**3.0002**

METHOD OF CONTROLLING MORTALITY IN CHANNEL CATFISH DUE TO CCV INFECTION ...**3.0005**

SUSCEPTIBILITY OF OTHER SPECIES OF CATFISHES TO CCV AND THEIR POSSIBLE ROLE AS CARRIERS ...**3.0007**

OYSTER DISEASE MORTALITY ALONG THE CALIFORNIA COAST ...**3.0022**

SURVEY OF ANIMAL DISEASES IN CONNECTICUT ...**3.0024**

MOLLUSCAN MORTALITY STUDIES ...**3.0032**

SHELLFISH MORTALITY - CHESAPEAKE BAY ...**3.0033**

PACIFIC OYSTER MORTALITY STUDIES ...**3.0034**

REFINEMENT OF MANAGEMENT TECHNIQUES FOR STREAM TROUT LAKES ...**3.0035**

RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT FINGERLINGS TO FURUNCULOSIS ...**3.0041**

THE RELATIONSHIP OF TEMPERATURE TO DISEASE OF SALMONID FISHES ...**3.0051**

ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...**3.0052**

MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...**3.0060**

SALT WATER POND RESEARCH ...**3.0073**

TESTING OF STOCKS OF OYSTERS FOR DISEASE RESISTANCE ...**3.0077**

MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...**3.0082**

EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...**3.0083**

ISOLATION OF VIRUSES FROM FISHES - INVESTIGATION OF FISH EPIZOOTICS OF UNKNOWN ETIOLOGY FOR POSSIBLE VIRUS INVOLVEMENT ...**3.0084**

MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...**3.0106**

PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...**3.0108**
TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS ...**3.0112**
PATHOLOGY - EPIZOOTIOLOGY ...**3.0113**
DISEASE-RESISTANT OYSTERS ...**3.0114**
EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...**3.0119**
BIOCHEMICAL CHANGES IN FISH DISEASES - THE STRESS OF FORMALIN TREATMENTS IN SALMONID FISHES ...**3.0124**
AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...**3.0126**

Number or Density
INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...**2.0087**

Productivity
BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...**2.0040**
EXPERIMENTS TO RE-ESTABLISH HISTORICAL OYSTER SEED GROUNDS AND TO CONTROL THE SOUTHERN OYSTER DRILL ...**2.0274**

Sex
MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...**1.0292**
SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...**2.0207**

Female
SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA - CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...**1.0268**
SUBLETHAL AMOUNTS OF ORGANIC INSECTICIDES AND FISH ...**1.0313**
INVESTIGATIONS OF PHEROMONES AS CHEMOSTERILANTS FOR INSECTS WITH SPECIAL REFERENCE TO SYNTHETIC QUEN SUBSTANCE AND ITS ANALOGUES ...**2.0021**
INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...**2.0025**
GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...**2.0034**
DEVELOPMENTS OF METHODS RELATED TO TESTING OF FISH CONTROL AGENTS BIOCHEMICAL METHOD FOR SEXING FISH ...**2.0248**
THE NUTRITION AND BEHAVIOR OF MOSQUITOES ...**4.0033**
DEVELOPMENT OF CULTURE METHODS FOR MOSQUITOES ...**4.0035**
THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...**4.0052**
GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...**4.0055**
PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA ...**4.0074**

Male
SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA - CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...**1.0268**
EFFECTS ON THE SPERMIATION RESPONSE OF GOLDFISH AFTER EXPOSURE TO SELECTED PESTICIDES ...**1.0270**
CYTOPLASMIC INCOMPATIBILITY FOR FILARIASIS CONTROL ...**2.0013**
GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...**2.0034**
RADIATION CYTOGENETICS OF THE YELLOW-FEVER MOSQUITO, AEDES AEGYPTI ...**2.0036**
DEVELOPMENTS OF METHODS RELATED TO TESTING OF FISH CONTROL AGENTS BIOCHEMICAL METHOD FOR SEXING FISH ...**2.0248**
BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN ...**4.0047**
THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...**4.0052**
GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...**4.0055**

Size
BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH ...**1.0261**
SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...**2.0207**
THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...**2.0261**
EVALUATION OF THE INFLUENCE OF AGE AND SIZE OF CHANNEL CATFISH ON THE INFECTIVITY OF CCV ...**3.0006**
IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...**3.0018**
DEVELOPMENT OF METHODS FOR COMMERCIAL PRODUCTION OF FROG LEGS FROM TADPOLES OF THE BULLFROG ...**3.0028**
ETIOLOGY OF ESTUARINE FISH DISEASES ...**3.0040**
TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS ...**3.0112**

Species, Comparison of
TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...**2.0007**
FACTORS AFFECTING ROLE OF MICROORGANISMS IN BIOLOGICAL CONTROL OF INSECT PESTS ...**2.0037**
SURVEY OF INSECT PROBLEMS IN MONTANA ...**2.0059**
BIOLOGICAL CONTROL OF WEEDS ...**2.0102**
NATURAL ENEMIES OF EURASIAN WATERMILFOIL IN PAKISTAN ...**2.0173**
ARTHROPOD-BORNE VIRUS (ARBOVIRUS) ACTIVITY IN MAJOR MOSQUITO VECTORS IN IOWA ...**4.0057**

Sterility
GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...**2.0034**
CYTOPLASMIC INHERITANCE AND CONTROL OF CULEX PIPIENS ...**2.0041**

Stress
BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH ...**1.0261**
INVESTIGATION OF STRESS-INDUCED MOBILIZATION OF INSECTICIDE RESIDUES - CHRONIC TOXICITY OF PESTICIDES TO FISH ...**1.0281**
EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - ORGANOCHLORINE PESTICIDES AND DISEASE RESISTANCE MECHANISMS OF RAINBOW TROUT ...**1.0312**
PATHOLOGY OF AEROMONAS LIQUIFACIENS IN CHANNEL CATFISH ...**3.0013**
EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...**3.0089**
MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...**3.0106**
EVALUATION OF STRESS IN FINGERLING SALMON THERAPEUTIC DRUGS AS STRESS FACTORS ...**3.0120**
THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...**4.0052**

Vigor
STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970 ...**1.0354**

Weight
PROCESSING, CHEMICAL COMPOSITION, AND NUTRITIVE VALUE OF AQUATIC WEEDS ...**2.0119**
ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...**3.0052**

Animal Environments

PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA ...4.0074

Farm Buildings & Shelters

CONTROL OF COMMON HOUSEFLY ...2.0005

Forest

INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087

BIOLOGICAL STUDIES OF CULICOIDES AND THEIR CONTROL IN THE CANAL ZONE ...4.0043

CALIFORNIA ENCEPHALITIS VIRUS IN WISCONSIN ...4.0075

Islands

INTERSPECIFIC COMPETITION AMONG MOSQUITOES ...2.0047

Laboratory

OYSTER DRIL (OCINEBRA JAPONICA) CONTROL ...2.0293

BIONOMICS OF SELECTED NORTH AMERICAN CULICINE MOSQUITOES ...4.0054

Animal Pharmacology

Drug Evaluation

U.V. SPECTROPHOTOMETRY FOR THE IDENTIFICATION AND ESTIMATION OF QUINALDINE RESIDUE ...2.0237

THE EFFICACY OF QUINALDINE SULFATE - MS-222 AS AN ANESTHETIC FOR FISH IN THE LABORATORY - WARM SPRINGS ...2.0239

INVESTIGATE CONTROL MEASURES OF BACTERIAL INFECTIONS IN FISH ...3.0003

TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS ...3.0112

EVALUATION OF STRESS IN FINGERLING SALMON THERAPEUTIC DRUGS AS STRESS FACTORS ...3.0120

IN VIVO CHEMOTHERAPEUTIC STUDIES ON FISH PATHOGENIC BACTERIA ...3.0121

CHEMOTHERAPEUTIC STUDIES ON FISH PATHOGENIC BACTERIA ...3.0123

EFFICACY OF A POTENTIATED SULFONAMIDE AGAINST FURUNCULOSIS INFECTIONS IN JUVENILE RAINBOW TROUT AND COHO SALMON ...3.0125

CHEMOTHERAPY OF FISH DISEASES ...3.0127

THE TOXICITY AND DRUG RESIDUE LEVEL OF CHLORAMPHENICOL IN TREATED RAINBOW TROUT ...3.0133

Drug Types

EVALUATION OF STRESS IN FINGERLING SALMON THERAPEUTIC DRUGS AS STRESS FACTORS ...3.0120

Anesthetics

CHRONIC TOXICITY OF PESTICIDES TO COLD-WATER FISH ...1.0318

RESIDUES OF MS-222 IN FISH ...2.0236

U.V. SPECTROPHOTOMETRY FOR THE IDENTIFICATION AND ESTIMATION OF QUINALDINE RESIDUE ...2.0237

THE EFFICACY OF QUINALDINE SULFATE - MS-222 AS AN ANESTHETIC FOR FISH IN THE LABORATORY - WARM SPRINGS ...2.0239

ROUTE(S) OF EXCRETION OF QUINALDINE SULFATE, A FISH ANESTHETIC ...2.0249

THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...2.0261

VERTEBRATE DISEASES - VIRAL DISEASES OF FRESHWATER FISHES AND OTHER LOWER VERTEBRATES EGTVED VIRUS ...3.0104

INVESTIGATION OF HANDLING TECHNIQUES ...3.0111

TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS ...3.0112

Antibiotics

EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH ...2.0260

INVESTIGATE CONTROL MEASURES OF BACTERIAL INFECTIONS IN FISH ...3.0003

TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS ...3.0112

CHEMOTHERAPEUTIC STUDIES ON FISH PATHOGENIC BACTERIA ...3.0123

THE TOXICITY AND DRUG RESIDUE LEVEL OF CHLORAMPHENICOL IN TREATED RAINBOW TROUT ...3.0133

Disinfectants

EFFECT OF DISINFECTING AGENTS ON M. CEREBRALIS ...3.0130

Drug Types -other

CONTROL OF MYXOSPORIDIAN PARASITES ...3.0109

CONTROL OF VIBRIOSIS IN SALMON ...3.0117

IN VIVO CHEMOTHERAPEUTIC STUDIES ON FISH PATHOGENIC BACTERIA ...3.0121

Formulation

CONTROL OF VIBRIOSIS IN SALMON ...3.0117

EVALUATION OF STRESS IN FINGERLING SALMON THERAPEUTIC DRUGS AS STRESS FACTORS ...3.0120

Mechanism of Action

EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH ...2.0260

Route of Administration

CONTROL OF VIBRIOSIS IN SALMON ...3.0117

Toxins

Plant Origin

MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...3.0056

CYTOPATHOGENIC EFFECT OF TOXIN ON TISSUE ...3.0086

CYTOPATHOGENIC EFFECT OF TOXIN IN FISH ...3.0087

Toxins -other

DEVELOPMENT OF RHODAMINE-B DYE TO TRACE FLOW AND DISPERSION PATTERNS IN STREAMS AS AN ADJUNCT TO TREATING STREAMS WITH FISH-CONTROL CHEMICALS ...2.0245

TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS ...3.0112

THE TOXICITY AND DRUG RESIDUE LEVEL OF CHLORAMPHENICOL IN TREATED RAINBOW TROUT ...3.0133

Animal Resistance to ....

Disease Resistance

INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...2.0029

THE BIOLOGY AND CONTROL OF THE SNAIL INTERMEDIATE HOST OF SCHISTOSOMES ...2.0276

RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT FINGERLINGS TO FURUNCULOSIS ...3.0041

RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT YEARLINGS TO FURUNCULOSIS ...3.0042

FIELD TESTING OF SELECTIVELY BRED STRAINS OF BROOK AND BROWN TROUT UNDER PRODUCTION HATCHERY CONDITIONS ...3.0043

INFECTIOUS DISEASES OF SALMONID FISHES ...3.0049

EPIDEMOLOGY OF 'SALMON POISONING' DISEASE ...3.0054

SALT WATER POND RESEARCH ...3.0073

NUTRITIONAL FACTORS IN THE DEVELOPMENT OF CORYNEBACTERIAL KIDNEY DISEASE ...3.0090

DISEASE-RESISTANT OYSTERS ...3.0114

Environment Resistance

CORRELATE NITROGEN GAS CONTENT OF WATER SUPPLIES WITH DISEASE ...3.0088
PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA ...4.0074

Parasite Resistance

FACTORS AFFECTING ROLE OF MICROORGANISMS IN BIOLOGICAL CONTROL OF INSECT PESTS ...2.0037
CULTIVATION OF INSECT PHASE OF AVIAN PLASMODIA ...4.0036

Animals - Mammals

Bos

LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...1.0212
BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...2.0040
ABUNDANCE, DISTRIBUTION AND CONTROL OF MISCELLANEOUS INSECTS, AFFECTING LIVESTOCK ...2.0056
THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078
EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082
INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087
EFFECT OF BITING FLIES ON WEIGHT GAINS IN CATTLE ...2.0090
THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...2.0130
INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...2.0280
TRANSMISSION OF ANAPLASMOSIS ...4.0032
BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...4.0045

Carnivora

Canis

NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077

Dogs, Laboratory Use Only

EPIDEMOLOGY OF 'SALMON POISONING' DISEASE ...3.0054
ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE ...4.0031
BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...4.0058

Felidae

NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077

Mustelidae

EFFECTS OF A SNAPPING TURTLE POPULATION ON THE WATERFOWL PRODUCTIVITY OF A MARSH ...2.0292

Procyonidae

EFFECTS OF A SNAPPING TURTLE POPULATION ON THE WATERFOWL PRODUCTIVITY OF A MARSH ...2.0292

Cricetidae -other

EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082

Cricetus

SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...2.0278
SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...2.0279

Livestock -nonspecific

INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...2.0010

Mammals -nonspecific

FACTORS AFFECTING PESTICIDE TOXICITY ...1.0255
ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...2.0083
SELECTIVE TOXICITY BY OPTICALLY ACTIVE PHOSPHONOTHIONATE PESTICIDES ...2.0086
PROCESSING, CHEMICAL COMPOSITION, AND NUTRITIVE VALUE OF AQUATIC WEEDS ...2.0119
EVALUATION OF WATERFOWL PREDATOR CONTROL METHODS ...2.0272

Muridae

Laboratory Rat

BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...1.0303
METABOLISM AND EXCRETION OF TFM ...2.0251

Mus

CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266
SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...2.0278
SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...2.0279
VIBRIO PARAHAEMOLYTICUS IN CHESAPEAKE BAY - ISOLATION, INCIDENCE AND PATHOGENICITY ...3.0026
ARTHROPOD-BORNE VIRUS (ARBOVIRUS) ACTIVITY IN MAJOR MOSQUITO VECTORS IN IOWA ...4.0057

Ovis

LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...1.0212
INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...2.0280
BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...4.0045

Rabbits and Pikas

ANALYTICAL METHODS FOR PESTICIDES AND PESTICIDE DEGRADATION PRODUCTS ...1.0088
THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078
CALIFORNIA ENCEPHALITIS VIRUS IN WISCONSIN ...4.0075

Rodentia -other

INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025
EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082

Sciuridae

Squirrel -nonspecific

CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...1.0235
FOREST AND FARM GAME HABITAT; FISH POND ...2.0143

Sus

JAPANESE ENCEPHALITIS ON GUAM ...4.0062

Vertebrates -nonspecific

COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...4.0049

Annelida

Hirudinea

PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...3.0047
ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044

Oligochaeta

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039
INSECTICIDES AND EGG-SHELL DEPOSITION ...1.0368
CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045

Polychaeta
MOLLUSCAN MORTALITY STUDIES ...3.0032

Anti-transpirants

FATE OF PESTICIDES ...1.0064

Antibiotics -see Pesticides

Chloramphenicol
THE TOXICITY AND DRUG RESIDUE LEVEL OF CHLORAMPHENICOL IN TREATED RAINBOW TROUT ...3.0133

Kojic Acid
MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...3.0056

Patulin
MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...3.0056

Appalachian Highlands

Appalachian Plateaus
RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION ...1.0194

Piedmont Province
DISPOSITION OF PESTICIDES IN THE SOIL ...1.0031
PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...1.0033

Application Equipment

MALARIA ERADICATION RESEARCH ...2.0051
TESTING OF METHODS OF HERBICIDE APPLICATION ...2.0126
AQUATIC PLANT CONTROL - EQUIPMENT FOR MECHANICAL AND CHEMICAL DESTRUCTION ...2.0147
DEVELOPMENT OF ACCURATE CHEMICAL INTRODUCTION TECHNIQUES ...2.0223

Application Methods

EFFECTS OF INSECTICIDES ON ACTIVITY OF SOIL INHABITING INSECTS ...1.0059
ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106
WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...2.0176

Aerial (any Type of Aircraft)
CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...1.0004
AERIAL DISPERSAL METHODS FOR CONCENTRATED INSECTICIDES ...2.0009

Application Methods -other
RESPROUTING OF CHAPARRAL ...1.0017
NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077

Contact Application
ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001
(U) REPELLENCY AND ATTRACTIVENESS OF MAN TO MOSQUITO BITES ...4.0040

Foam Application
CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086

Foliar Application
CHEMICAL CONTROL OF DITCHBANK WEEDS IN PEAT AND SANDY SOIL AREAS OF SOUTH FLORIDA ...2.0114
EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...2.0116
EXPANDED AQUATIC PLANT CONTROL PROJECT ...2.0146

Oral Application
INSECTS AFFECTING MAN AND ANIMALS ...2.0081
DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...4.0051

Post-emergents
WEED CONTROL IN RICE PRODUCTION ...2.0098
CHEMICAL CONTROL OF DITCHBANK WEEDS IN PEAT AND SANDY SOIL AREAS OF SOUTH FLORIDA ...2.0114
USE OF CHEMICALS ON RICE ...2.0140

Pre-emergents
USE OF CHEMICALS ON RICE ...2.0140

Preplant Application
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145

Seed Treatment
CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...1.0235

Skin, Dermal, Topical -animal
INSECTS AFFECTING MAN AND ANIMALS ...2.0081

Surface -soil
INACTIVATION AND LOSS PESTICIDES FROM SOIL ...1.0048
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
CONTROL OF CANADA THISTLE AND WATER WEEDS ...2.0158

Time-release Capsules
DEVELOPMENT OF A TECHNIQUE FOR THE CONTROLLED SELF-DESTRUCTION OF FIELD-APPLIED DDT ...1.0014
EVALUATION AND DEMONSTRATION OF IRRIGATION METHODS AND PRACTICES TO REDUCE CONTAMINATION IN IRRIGATION WASTE WATER ...1.0104
ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106
NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077
BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115
EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...2.0116
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0118
CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...2.0185
THE EFFICACY OF NEW FORMULATIONS OF ANTIMYCIN IN NATURAL LAKES AND STREAMS ...2.0246

Water Application
INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015
HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...1.0107
EFFECT OF COPPER SULFATE ON AQUATIC WEEDS ...2.0108
TESTING OF METHODS OF HERBICIDE APPLICATION ...2.0126
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...2.0160

Application Methods

DEVELOPMENT OF ACCURATE CHEMICAL INTRODUCTION TECHNIQUES ...2.0223

Application Timing

Diurnal, Time of Day

SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...2.0055

Maturity or Growth Stage

THE SUSCEPTIBILITY OF VARIOUS LIFE STAGES OF FRESHWATER FISHES TO THREE TOXICANTS ...1.0279

EFFECT OF PESTICIDE RESIDUES ON GAME FISH POPULATIONS ...1.0310

GROWTH SUPPRESSION AND REDUCTION IN REGROWTH POTENTIAL OF AQUATIC WEEDS ...2.0110

LABORATORY STUDY OF AQUATIC ENVIRONMENTAL FACTORS AND PLANT GROWTH STAGES ON AQUATIC WEED GROWTH AND HERBICIDAL RESPONSE ...2.0111

SELECTIVE REMOVAL OF VARIOUS FISH SPECIES WITH ANTIMYCIN ...2.0240

THE EFFICACY OF MONSANTO NO. 51294 AS A FISH TOXICANT (LABORATORY) ...2.0243

STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES ...2.0256

Sequential, Daily, Weekly, Etc

WEED CONTROL IN RICE PRODUCTION ...2.0098

GROWTH SUPPRESSION AND REDUCTION IN REGROWTH POTENTIAL OF AQUATIC WEEDS ...2.0110

Timing -nonspecific

CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025

CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...1.0189

AQUATIC WEED CONTROL RESEARCH ...2.0100

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104

CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187

Timing -other

WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...1.0050

BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115

WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...2.0179

Aquaculture

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029

AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...3.0126

Fish Farming

PHYSICAL AND CHEMICAL FACTORS AFFECTING FISH ...1.0246

FARM FISH POND MANAGEMENT ...1.0340

DEVELOPMENT OF METHODS FOR COMMERCIAL PRODUCTION OF FROG LEGS FROM TADPOLES OF THE BULLFROG ...3.0028

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029

IDENTIFICATION OF PARASITES AND DISEASES EFFECTING MARICULTURE SPECIES ...3.0037

AQUICULTURE, SALMON CULTURE - RESEARCH ...3.0053

Plant Aquaculture

ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...1.0326

Shellfish Farming

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...1.0236

EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE I ...2.0073

EXPERIMENTS TO RE-ESTABLISH HISTORICAL OYSTER SEED GROUNDS AND TO CONTROL THE SOUTHERN OYSTER DRILL ...2.0274

OYSTER DRIL (OCINEBRA JAPONICA) CONTROL ...2.0293

PACIFIC OYSTER MORTALITY STUDIES ...3.0034

IDENTIFICATION OF PARASITES AND DISEASES EFFECTING MARICULTURE SPECIES ...3.0037

SALT WATER POND RESEARCH ...3.0073

TESTING OF STOCKS OF OYSTERS FOR DISEASE RESISTANCE ...3.0077

ACQUIRED VS. GENETIC RESISTANCE IN OYSTERS ...3.0078

TESTS OF SELECTED SEED OYSTER STOCKS ON COMMERCIAL BEDS ...3.0079

DISEASE-RESISTANT OYSTERS ...3.0114

AQUICULTURE, OYSTER HATCHERIES - RESEARCH ...3.0118

Aquatic or Soil-aquatic Cycles

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0002

FATE OF HARMFUL METALS IN SOIL AND WATER SYSTEMS ...1.0003

WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...1.0005

PESTICIDE RESIDUES ON ARIZONA CROPS ...1.0007

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010

MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS ...1.0011

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013

VOLATILIZATION LOSSES OF PESTICIDES FROM SOILS ...1.0016

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019

REACTIONS OF PESTICIDES WITH SOILS ...1.0020

REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...1.0021

BEHAVIOR OF POLLUTANTS IN WATER ...1.0022

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023

CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...1.0024

MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS ...1.0028

DISPOSITION OF PESTICIDES IN THE SOIL ...1.0031

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...1.0032

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034

POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...1.0036

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0037

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0038

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039

REDUCTION OF PESTICIDE RESIDUE HAZARDS ...1.0040

INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0043

MOVEMENT OF HERBICIDES IN SOIL BY MASS FLOW ...1.0044

REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...1.0047

INACTIVATION AND LOSS PESTICIDES FROM SOIL ...1.0048

ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS ...1.0049
WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...1.0050
CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...1.0051
PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...1.0052
CONTROL OF PESTICIDES IN SOIL AND WATER ...1.0054
PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS ...1.0055
TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...1.0056
RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...1.0057
ANALYSIS OF PESTICIDE RESIDUES ...1.0058
EFFECTS OF INSECTICIDES ON ACTIVITY OF SOIL INHABITING INSECTS ...1.0059
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061
SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...1.0066
ENVIRONMENTAL BIOLOGY - BIOGEOCHEMICAL CYCLING IN ECOLOGICAL SYSTEMS ...1.0068
MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...1.0071
SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072
NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073
PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...1.0075
FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL ...1.0077
FATE OF POLLUTANTS IN GROUND WATER ...1.0079
EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS ...1.0080
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081
BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0084
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0085
PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...1.0090
PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...1.0094
FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095
PERSISTENCE AND MODES OF HERBICIDE DISSIPATION UNDER RANGELAND CONDITIONS ...1.0096
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0097
MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...1.0098
MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099
EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...1.0100
EFFECT OF PESTICIDES ON THE QUALITY OF SURFACE AND GROUND WATERS IN THE WESTERN GULF REGION ...1.0101
QUALITY OF IRRIGATION RETURN FLOW ...1.0102
SOILS, PESTICIDES, AND THE QUALITY OF WATER ...1.0103
EVALUATION AND DEMONSTRATION OF IRRIGATION METHODS AND PRACTICES TO REDUCE CONTAMINATION IN IRRIGATION WASTE WATER ...1.0104
ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106
INTERFERING SOIL CONSTITUENTS IN DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND WATER ...1.0109
IDENTIFICATION AND DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND RUNOFF AND DRAINAGE WATERS. ...1.0110
FATE OF INSECTICIDES IN SOIL AND THEIR MOVEMENT IN WATER AND CROPS ...1.0111
GREEN BAY RESEARCH PROGRAM ...1.0112
METABOLISM OF ENDRIN IN PONDS ...1.0113
ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120
PREDICTING MINERAL QUALITY OF RETURN FLOW WATER ...1.0122
ATTENTION AND RUNOFF OF PESTICIDES FROM AGRICULTURAL LANDS TO SURFACE WATERS ...1.0124
COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...1.0125
PESTICIDE KINETICS ...1.0127
ESTUARINE ECOSYSTEMS ...1.0128
EFFLUENT INFLUENCES OF THE MISSISSIPPI RIVER ON THE CHEMISTRY AND BIOLOGY OF ADJACENT OCEAN SYSTEMS ...1.0130
ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN ...1.0132
EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133
UPPER ST. JOHNS RIVER BASIN WATER QUALITY, FLORIDA ...1.0134
RURAL RUNOFF CONTROL ...1.0135
DEVELOP EFFECTIVE TREATMENT METHODS FOR HARD PESTIDICIDES ...1.0136
RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS ...1.0138
TOXAPHENE CONTAMINATION - ESTUARINE ECOLOGY ...1.0139
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0141
STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES ...1.0142
THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0144
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146
THE FACTOR CONTROLLING THE DYNAMICS OF NONIONIC SYNTHETIC ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS ...1.0148
LIMNOLOGICAL FACTORS AFFECTING PESTICIDE RESIDUES IN SURFACE WATERS ...1.0149
GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152
POLLUTION LOADS IN RUNOFF FROM SMALL AGRICULTURAL WATERSHEDS ...1.0154
MASSACHUSETTS PESTICIDE MONITORING STUDY ...1.0157
ADSORPTION OF PESTICIDES FROM SEA WATER ...1.0159
AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161
WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...1.0162
PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0163
PESTICIDE TESTING FOR SETTING STANDARDS ...1.0165
PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166
PRESTICIDE INPUTS AND LEVELS IN MINNESOTA WATERS OF THE LAKE SUPERIOR BASIN ...1.0167
PREPARATION OF CHLORINE-36 LABELED ORGANOCHLORINE PESTICIDES AND RELATED COMPOUNDS (PCB'S) ...1.0174
THE EFFECTS OF HERBICIDES, PESTICIDES, AND FERTILIZERS ON THE OPTICAL PROPERTIES OF WATER ...1.0177
FERTILIZERS AND SEDIMENTS AS WATER POLLUTANTS ...1.0179
RAPID DETECTION OF TOXIC MATERIALS IN WATER ...1.0180
SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...1.0181
GROUND AND SURFACE WATERS - POLLUTION ...1.0182
DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183

QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...**1.0187**
CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...**1.0189**
CENTER FOR STUDY OF THE HUMAN ENVIRONMENT ...**1.0190**
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...**1.0191**
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...**1.0192**
PESTICIDES MOVEMENT FROM CROPLAND INTO LAKE ERIE ...**1.0193**
RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION ...**1.0194**
DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...**1.0196**
DEVELOP EFFECTIVE TREATMENT METHODS FOR HARD PESTICIDES ...**1.0197**
QUANTITATIVE METHODS FOR PESTICIDES IN NATURAL WATERS ...**1.0198**
PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...**1.0199**
TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE ...**1.0201**
TRANSFER OF PESTICIDES THROUGH SOILS, WATER, SEDIMENTS AND AQUATIC LIFE ...**1.0202**
CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...**1.0205**
PESTICIDE LEVELS IN WATER AND WILDLIFE OF REELFOOT LAKE, TENNESSEE ...**1.0208**
INVESTIGATION OF RICE IRRIGATION RETURN FLOWS - TEXAS COASTAL PRAIRIE REGION ...**1.0209**
CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...**1.0210**
DDT IN SNOW FALLEN AT HIGH ALTITUDE SINCE 1950 ...**1.0214**
DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...**1.0215**
IMPROVING WATER QUALITY BY REMOVAL OF PESTICIDE POLLUTANTS WITH AQUATIC PLANTS ...**1.0216**
SOURCES OF QUALITY IMPAIRMENT OF SURFACE WATERS ...**1.0218**
OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...**1.0219**
EVALUATION OF PESTICIDE SOURCES AND LEVELS TRIBUTARY TO LAKES MICHIGAN AND SUPERIOR ...**1.0221**
THE OCCURRENCE OF PESTICIDE RESIDUES IN THE LOWER BRISBANE RIVER AND IN THE TISSUES OF ESTUARINE ANIMALS ...**1.0233**
CONTAMINATION OF CHANNEL CATFISH WITH DIELDRIN FROM AGRICULTURAL RUNOFF ...**1.0247**
PESTICIDE CONTAMINATION OF ENVIRONMENT ...**1.0250**
RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...**1.0256**
CHRONIC EFFECTS OF DURSBAN ON WARM-WATER FISH ...**1.0282**
THE RELATIONSHIP BETWEEN THE USE OF AGRICULTURAL CHLORINATED HYDROCARBONS AND THEIR RESIDUES IN CHANNEL CATFISH ...**1.0298**
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...**1.0304**
RESIDUES OF TFM IN FISH--LA CROSSE ...**1.0315**
PESTICIDES AND WILDLIFE ...**1.0324**
THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...**1.0330**
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...**1.0334**
MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS ...**1.0338**
ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...**1.0339**
BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...**1.0342**
INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0351**
BIODEGRADATION OF PESTICIDES IN A FRESHWATER ECOSYSTEM - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0352**
PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...**1.0358**
TOXICOLOGY OF PESTICIDES IN THE ENVIRONMENT ...**1.0360**
ENVIRONMENTAL TOXICOLOGY OF PESTICIDES ...**1.0361**
PHARMACOLOGICAL AND ECOLOGICAL EFFECTS OF PESTICIDES ...**1.0362**
CHEMICAL BIOCIDES IN LAKES ...**1.0364**
INSECTICIDES AND EGG-SHELL DEPOSITION ...**1.0368**
EFFECT OF MOSQUITO CONTROL CHEMICALS ON AQUATIC FAUNA ...**2.0003**
CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...**2.0101**
PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...**2.0105**
HERBICIDE RESIDUES ...**2.0109**
THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...**2.0150**
RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...**2.0161**
BIOLOGY AND CONTROL OF AQUATIC WEEDS ...**2.0162**
CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...**2.0185**
METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...**2.0186**
THE EFFICACY AND PERSISTENCE OF FORMULATIONS OF ANTIMYCIN ...**2.0244**
INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...**4.0027**

Aquatic Soils

CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...**1.0024**
REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0037**
EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...**1.0041**
TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...**1.0056**
MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...**1.0099**
UPTAKE AND RELEASE OF DALAPON IN EARTHEN PONDS ...**1.0114**
ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...**1.0120**
COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...**1.0125**
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...**1.0140**
PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...**1.0143**
THE FACTOR CONTROLLING THE DYNAMICS OF NON-IONIC SYNTHETIC ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS ...**1.0148**
PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...**1.0163**
PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...**1.0170**
SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...**1.0181**
PESTICIDES MOVEMENT FROM CROPLAND INTO LAKE ERIE ...**1.0193**
TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE ...**1.0201**
TRANSFER OF PESTICIDES THROUGH SOILS, WATER, SEDIMENTS AND AQUATIC LIFE ...**1.0202**

CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...1.0205

DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215

INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0223

INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0224

CHLORINATED ORGANIC CONTAMINANTS IN THE MILWAUKEE RIVER ...1.0226

EFFECT OF ENDRIN ON FISH AND THEIR ENVIRONMENT UNDER CONTROLLED CONDITIONS ...1.0230

PESTICIDES AND WILDLIFE ...1.0324

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...1.0328

FARM FISH POND MANAGEMENT ...1.0340

INSECTICIDES AND EGG-SHELL DEPOSITION ...1.0368

AQUATIC WEED CONTROL RESEARCH ...2.0100

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104

AQUATIC PEST CONTROL ...2.0112

AQUATIC PLANT CONTROL ...2.0128

CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...2.0154

BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162

CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...2.0185

CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187

AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...4.0011

EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...4.0023

NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE ...4.0025

Aquifers

FATE OF POLLUTANTS IN GROUND WATER ...1.0079

MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099

EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...1.0100

Carbonate Aquifers

PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...1.0094

Clastic Aquifers

NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...4.0015

Arachnida

Acarina

Acaridae

EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS ...1.0341

Ixodides

INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...2.0030

BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...2.0040

ABUNDANCE, DISTRIBUTION AND CONTROL OF MISCELLANEOUS INSECTS, AFFECTING LIVESTOCK ...2.0056

ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE ...4.0031

TRANSMISSION OF ANAPLASMOSIS ...4.0032

Mites -nonspecific

ABUNDANCE, DISTRIBUTION AND CONTROL OF MISCELLANEOUS INSECTS, AFFECTING LIVESTOCK ...2.0056

Plant Mites

EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...2.0002

Phalangida

EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS ...1.0341

Argentina

SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...2.0095

Argon

LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010

Aromatic Compounds

ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT ...1.0131

AROMATIC SOLVENT AQUATIC HERBICIDES AND EMULSIFYING AGENT TESTING ...2.0107

Arsenic

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0002

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0097

ATOMIC ABSORPTION ANALYSIS OF PHOSPHATES IN WATER ...1.0227

Arthropods -nonspecific

GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152

STUDY ON THE EFFECTS OF FISH TOXICANTS ANTIMYCIN A AND ROTENONE ON POND COMMUNITIES ...1.0366

ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE ...4.0031

Aschelminthes -other

PESTICIDES AND WILDLIFE ...1.0324

IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...3.0018

PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...3.0047

Astronomy

ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...4.0007

Atlantic Ocean

EFFLUENT INFLUENCES OF THE MISSISSIPPI RIVER ON THE CHEMISTRY AND BIOLOGY OF ADJACENT OCEAN SYSTEMS ...1.0130

A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0140

A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0158

DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...1.0184

PESTICIDE MONITORING PROGRAM ...1.0238

NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...2.0271

SEA NETTLE STUDIES IN CHESAPEAKE BAY, LIFE HISTORY AND ECOLOGY ...2.0273

VIBRIO PARAHAEMOLYTICUS IN CHESAPEAKE BAY - ISOLATION, INCIDENCE AND PATHOGENICITY ...3.0026

MOLLUSCAN MORTALITY STUDIES ...3.0032

SHELLFISH MORTALITY - CHESAPEAKE BAY ...3.0033

IDENTIFICATION OF PARASITES AND DISEASES EFFECTING MARICULTURE SPECIES ...3.0037

BACTERIAL AND VIRAL DISEASES AND CELL CULTURES OF MARINE FISH AND SHELLFISH ...3.0074

A HISTOLOGIC STUDY OF MARINE FISH ...3.0076

PATHOLOGY - EPIZOOTIOLOGY ...3.0113

DISEASE-RESISTANT OYSTERS ...3.0114

BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...4.0012

Atlases - Maps

GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152

Atmosphere Composition

ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...4.0007

Attractants

Attractants - Other

STATIC BIOASSAY OF ATTRACTANTS AND REPELLANTS AGAINST FISH AND INVERTEBRATES ...2.0258

'A METHOD OF DESTROYING ONCOMELANIA-THE SNAIL VECTOR OF SCHISTOSOMIASIS' ...2.0284

METHOD OF KILLING ONCOMELANIA & AQUATIC SNAIL VECTORS OF SCHISTOSOMIASIS ...2.0285

Insect Attractants

SUPPRESSION AND ECOLOGY OF MOSQUITOES ...2.0018

INVESTIGATIONS OF PHEROMONES AS CHEMOSTERILANTS FOR INSECTS WITH SPECIAL REFERENCE TO SYNTHETIC QUEN SUBSTANCE AND ITS ANALOGUES ...2.0021

SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...2.0028

NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...2.0079

MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085

ATTRACTIVENESS AND REPELLENCY OF MAN TO MOSQUITO BITES ...4.0041

BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN ...4.0047

Augmentation -general

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168

NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180

Australia

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010

Automated Equipment

ANALYTICAL METHODS FOR PESTICIDES IN SOIL AND WATER ...1.0018

RAPID DETECTION OF TOXIC MATERIALS IN WATER ...1.0180

Autopsy

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269

DEVELOPMENTS OF METHODS RELATED TO TESTING OF FISH CONTROL AGENTS BIOCHEMICAL METHOD FOR SEXING FISH ...2.0248

PATHOLOGY OF AEROMONAS LIQUIFACIENS IN CHANNEL CATFISH ...3.0013

SURVEY OF ANIMAL DISEASES IN CONNECTICUT ...3.0024

ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...3.0052

Autoradiography

DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...1.0333

Aziridines

INSECT CHEMOSTERILANTS ...2.0049

Azo Compounds

GROUND AND SURFACE WATERS - POLLUTION ...1.0182

Bacteria

Aeromonas

PATHOLOGY OF AEROMONAS LIQUIFACIENS IN CHANNEL CATFISH ...3.0013

RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT FINGERLINGS TO FURUNCULOSIS ...3.0041

RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT YEARLINGS TO FURUNCULOSIS ...3.0042

FIELD TESTING OF SELECTIVELY BRED STRAINS OF BROOK AND BROWN TROUT UNDER PRODUCTION HATCHERY CONDITIONS ...3.0043

INFECTIOUS DISEASES OF SALMONID FISHES ...3.0049

BACTERIOLOGICAL AND SEROLOGICAL STUDIES ON MOTILE AEROMONADS AND PSEUDOMONADS FRESHLY ISOLATED FROM DISEASED FISHES ...3.0096

DETECTION OF CARRIER CONDITION IN FURUNCULOSIS ...3.0098

RELATIONSHIP OF TEMPERATURE TO DISEASES OF SALMONID FISH ...3.0116

ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - FURUNCULOSIS IN COHO SALMON ...3.0122

EFFICACY OF A POTENTIATED SULFONAMIDE AGAINST FURUNCULOSIS INFECTIONS IN JUVENILE RAINBOW TROUT AND COHO SALMON ...3.012[illegible]

Anaerobic Bacteria

ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT ...1.0131

Bacilli -nonspecific

BIOLOGY OF MICROORGANISMS OF MOSQUITOES ...2.0022

Bacillus -other

MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...2.0019

Bacillus Licheniformis

THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...1.0359

Bacillus Thuringiensis

EMERGENCY INSECT CONTROL ...2.0076

Bacteria -nonspecific

TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...2.0007
IDENTIFICATION AND CHARACTERIZATION OF MOSQUITO PATHOGENS ...2.0020
BIOLOGICAL CONTROL OF INSECTS AFFECTING MAN ...2.0027
INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...2.0029
FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...2.0053
IDENTIFICATION OF PARASITIC BACTERIAL FORMS ...3.0002
INVESTIGATE CONTROL MEASURES OF BACTERIAL INFECTIONS IN FISH ...3.0003
COOPERATIVE FISH PARASITE AND DISEASE STUDY ...3.0015
MOLLUSCAN MORTALITY STUDIES ...3.0032
BACTERIAL FLORA OF APPARENTLY HEALTHY STRIPED BASS (ROCCUS SAXATILIS) & ITS CORRELATION WITH THE BACTERIA OF THE HATCHERY WATER SUPPLY ...3.0046
USE OF CELL CULTURE METHODS TO ATTEMPT TO FOLLOW DEVELOPING STAGES OF SPORES ...3.0062
BACTERIAL AND VIRAL DISEASES AND CELL CULTURES OF MARINE FISH AND SHELLFISH ...3.0074
CYTOPATHOGENIC EFFECT OF TOXIN ON TISSUE ...3.0086
CYTOPATHOGENIC EFFECT OF TOXIN IN FISH ...3.0087
DEVELOPMENT OF METHODS FOR RAPID IDENTIFICATION OF BACTERIAL FISH PATHOGENS ...3.0097
SPAWNING AND REARING OF MARINE FISH ...3.0110
IN VIVO CHEMOTHERAPEUTIC STUDIES ON FISH PATHOGENIC BACTERIA ...3.0121
CHEMOTHERAPEUTIC STUDIES ON FISH PATHOGENIC BACTERIA ...3.0123
CHEMOTHERAPY OF FISH DISEASES ...3.0127

Chondrococcus

RELATIONSHIP OF TEMPERATURE TO DISEASES OF SALMONID FISH ...3.0116
AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...3.0126

Clostridium Botulinum

THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...1.0359

Coliforms

INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0116
AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117
MAYFLY DISTRIBUTION AS A WATER QUALITY INDEX ...1.0169
GROUND AND SURFACE WATERS - POLLUTION ...1.0182
QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187
QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204
SOURCES OF QUALITY IMPAIRMENT OF SURFACE WATERS ...1.0218
MICROBIOLOGY OF FARM PONDS ...1.0220
GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081

Corynebacteria

NUTRITIONAL FACTORS IN THE DEVELOPMENT OF CORYNEBACTERIAL KIDNEY DISEASE ...3.0090

Escherichia Coli

INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0116
EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155
THE EFFECTS OF DIFFERENTLY EXTRACTED ENDOTOXINS FROM ESCHERICHIA COLI ON RAINBOW TROUT (SALMO GAIRDNERI) ...3.0071

Gram-negative Bacteria

PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...1.0087
MICROBIOLOGY OF FARM PONDS ...1.0220

Gram-positive Bacteria

MICROBIOLOGY OF FARM PONDS ...1.0220

Intestinal Bacteria

AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117

Marine Bacteria

ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT ...1.0131

Nitrogen Bacteria

PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN ...1.0213
MICROBIOLOGY OF FARM PONDS ...1.0220
ALGACIDES FOR USE IN WATER RECLAMATION AND REUSE SYSTEMS ...2.0177

Oral Bacteria

ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - RED MOUTH COMPARATIVE VACCINE STUDY ...3.0085
HISTOPATHOLOGY OF SALMONID FISHES - BACTERIAL RED-MOUTH DISEASE HISTOPATHOGENESIS OF RAINBOW TROUT (SALMON GAIRDNERI) ...3.0093

Pseudomonas

ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT ...1.0131
BACTERIOLOGICAL AND SEROLOGICAL STUDIES ON MOTILE AEROMONADS AND PSEUDOMONADS FRESHLY ISOLATED FROM DISEASED FISHES ...3.0096

Rhizobium

INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0043

Salmonella

INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0116
AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117

Sewage Bacteria

MICROBIOLOGY OF FARM PONDS ...1.0220

Soil Bacteria

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023
MULTI-DISCIPLINARY RESEARCH IN POLLUTION ...1.0070
PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...1.0087

Sphaerotilus

OCCURRENCE OF FILAMENTOUS SLIMES ORGANISMS BELOW OUTFALLS ...4.0009

Streptococcus Fecalis

INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0116
MICROBIOLOGY OF FARM PONDS ...1.0220

Vibrio

VIBRIO PARAHAEMOLYTICUS IN CHESAPEAKE BAY - ISOLATION, INCIDENCE AND PATHOGENICITY ...3.0026
CONTROL OF VIBRIOSIS IN SALMON ...3.0117
EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...3.0119

AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...3.0126

Water Bacteria

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...1.0032
EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...1.0100
DEVELOP IN-HOUSE CAPABILITY IN WATER QUALITY TECHNIQUES FOR ANALYSES OF HEAVY METALS, BACTERIA, AND PESTICIDE RESIDUES ...1.0171
GROUND AND SURFACE WATERS - POLLUTION ...1.0182
ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211
PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN ...1.0213
INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0351
BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...2.0121
LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...2.0184
PUBLICATION OF FISH BACTERIAL RESEARCH ...3.0016

Bacterial Studies

Classification or Taxonomy

PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN ...1.0213

Ecology

PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN ...1.0213
MICROBIOLOGY OF FARM PONDS ...1.0220
EPIZOOTIOLOGY OF LEPTOSPIRES - FISH SUSCEPTIBILITY TO L. ICTEROHAEMORRHIGICA (ABBREV) ...3.0023
OCCURRENCE OF FILAMENTOUS SLIMES ORGANISMS BELOW OUTFALLS ...4.0009

Identification

PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...1.0087
MICROBIOLOGY OF FARM PONDS ...1.0220
IDENTIFICATION OF PARASITIC BACTERIAL FORMS ...3.0002
VIBRIO PARAHAEMOLYTICUS IN CHESAPEAKE BAY - ISOLATION, INCIDENCE AND PATHOGENICITY ...3.0026

Isolation From Nat. Environ.

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023
INTERACTION OF HERBICIDES AND SOIL MICROORGANISMS ...1.0069
MULTI-DISCIPLINARY RESEARCH IN POLLUTION ...1.0070
PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...1.0087
ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT ...1.0131
LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...2.0184
IDENTIFICATION OF PARASITIC BACTERIAL FORMS ...3.0002
COOPERATIVE FISH PARASITE AND DISEASE STUDY ...3.0015
BACTERIAL FLORA OF APPARENTLY HEALTHY STRIPED BASS (ROCCUS SAXATILIS) & ITS CORRELATION WITH THE BACTERIA OF THE HATCHERY WATER SUPPLY ...3.0046
ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - RED MOUTH COMPARATIVE VACCINE STUDY ...3.0085
BACTERIOLOGICAL AND SEROLOGICAL STUDIES ON MOTILE AEROMONADS AND PSEUDOMONADS FRESHLY ISOLATED FROM DISEASED FISHES ...3.0096
AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...3.0126

Morphology

BACTERIOLOGICAL AND SEROLOGICAL STUDIES ON MOTILE AEROMONADS AND PSEUDOMONADS FRESHLY ISOLATED FROM DISEASED FISHES ...3.0096

Serology

BACTERIOLOGICAL AND SEROLOGICAL STUDIES ON MOTILE AEROMONADS AND PSEUDOMONADS FRESHLY ISOLATED FROM DISEASED FISHES ...3.0096
CONTROL OF VIBRIOSIS IN SALMON ...3.0117
AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...3.0126

Barbiturates

CHRONIC TOXICITY OF PESTICIDES TO COLD-WATER FISH ...1.0318
EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...2.0234

Bays

GREEN BAY RESEARCH PROGRAM ...1.0112
ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120
EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133
GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152
PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...1.0358
SEA NETTLE STUDIES IN CHESAPEAKE BAY, LIFE HISTORY AND ECOLOGY ...2.0273
OYSTER DISEASE MORTALITY ALONG THE CALIFORNIA COAST ...3.0022
UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029
SHELLFISH MORTALITY - CHESAPEAKE BAY ...3.0033
MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...3.0060
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082
PATHOLOGY - EPIZOOTIOLOGY ...3.0113
EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...3.0119
EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029

Beds Under Water

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168

Beef Husbandry

EFFECT OF BITING FLIES ON WEIGHT GAINS IN CATTLE ...2.0090

Benthos

Benthic Fauna

BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342
BIOLOGICAL FACTORS IN THE MANAGEMENT OF LAKE FLIES ...2.0088
EXPERIMENTAL RECLAMATION OF TROUT STREAMS THROUGH CHEMICAL TREATMENT ...2.0263
RENOVATION OF TROUT STREAMS ...4.0076

Benthic Flora

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...4.0018

EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...**4.0023**

Benthic Organisms -nonspecific

GREEN BAY RESEARCH PROGRAM ...**1.0112**

A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...**1.0140**

A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...**1.0158**

OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...**1.0219**

FIELD STUDIES OF PESTICIDE EFFECTS ON FISHES ...**1.0257**

THE CRAYFISH (ORCONECTES CAUSEYI) AS A BIOLOGICAL CONTROL OF AQUATIC VEGETATION ...**2.0175**

RESEARCH VESSEL OPERATIONS ...**3.0048**

EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...**4.0029**

POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...**4.0078**

Benzene

ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT ...**1.0131**

Benzimidazole

BIOLOGY AND CONTROL OF TERRESTIAL MOLLUSKS ...**2.0289**

Bile

BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...**1.0303**

Bilirubin

EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...**2.0234**

Bioassays

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0002**

WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...**1.0005**

PESTICIDE RESIDUES ON ARIZONA CROPS ...**1.0007**

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...**1.0039**

MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...**1.0071**

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...**1.0081**

PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...**1.0090**

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...**1.0091**

DEVELOPMENT OF ON-SITE BIOASSAY METHODS ...**1.0108**

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...**1.0143**

RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...**1.0146**

PESTICIDE MONITORING PROGRAM ...**1.0156**

PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...**1.0163**

PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...**1.0166**

PRESTICIDE INPUTS AND LEVELS IN MINNESOTA WATERS OF THE LAKE SUPERIOR BASIN ...**1.0167**

A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...**1.0168**

MAYFLY DISTRIBUTION AS A WATER QUALITY INDEX ...**1.0169**

RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION ...**1.0194**

THE BIOASSAY OF WATER POLLUTANTS WITH CULTURED MAMMALIAN CELLS ...**1.0200**

ARTIFICIAL SUBSTRATE SAMPLERS AS INDICATORS OF WATER QUALITY ...**1.0225**

PESTICIDE MONITORING PROGRAM ...**1.0238**

ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...**1.0239**

LABORATORY BIOASSAYS ...**1.0241**

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...**1.0249**

THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...**1.0253**

LABORATORY BIOASSAYS TO DETERMINE TOXIC EFFECS OF METHOXYCHLOR IN FISH ...**1.0264**

MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...**1.0266**

THE INFLUENCES OF ENVIRONMENTAL CONDITIONS ON THE TOXICITY OF PESTICIDES ...**1.0278**

THE SUSCEPTIBILITY OF VARIOUS LIFE STAGES OF FRESHWATER FISHES TO THREE TOXICANTS ...**1.0279**

RELATIVE SUSCEPTIBILITIES OF FISH FAMILIES TO HERBICIDES ...**1.0280**

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0288**

THE UPTAKE OF DIELDRIN IN THE THREE RIDGED NAIAD, AMBLEMA PLICATA ...**1.0301**

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...**1.0305**

STATIC BIOASSAY OF TRACERS AND DYES AGAINST FISH AND INVERTEBRATES ...**1.0316**

INFLUENCE OF PROTOZOAN ACTIVITY ON HALOGENATED HYDROCARBON RESIDUES - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0349**

MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...**2.0062**

SEA LAMPREY CONTROL - LAKE MICHIGAN CHEMICAL CONTROL ...**2.0203**

LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...**2.0205**

LAKE HURON CHEMICAL CONTROL ...**2.0209**

BIOASSAY ...**2.0211**

TIME-CONCENTRATION TESTS INVOLVING NEUTRALIZATION OF ROTENONE WITH POTASSIUM PERMANGANATE ...**2.0224**

PISCICIDE TOXICOLOGY OF THE CYPRINIDS IN EAST AND WEST PAULINA LAKES ...**2.0228**

EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT) ...**2.0229**

EVALUATE FISH TOXICANT (ANTIMYCIN) (EAGLE LAKE SEGMENT) ...**2.0230**

STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...**2.0255**

STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES ...**2.0256**

STATIC BIOASSAY OF COLLECTING AIDS AGAINST FISH ...**2.0257**

STATIC BIOASSAY OF ATTRACTANTS AND REPELLANTS AGAINST FISH AND INVERTEBRATES ...**2.0258**

CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...**2.0259**

PATHOLOGY RESEARCH ...**3.0027**

INVESTIGATION OF HANDLING TECHNIQUES ...**3.0111**

THE TOXICITY AND DRUG RESIDUE LEVEL OF CHLORAMPHENICOL IN TREATED RAINBOW TROUT ...**3.0133**

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...**4.0018**

Biological Control

CLASSIFICATION, BIONOMICS, ECOLOGY CONTROL OF FOREST INSECTS (OTHER THAN SCOLYTIDAE) IN CAL. ...**1.0321**

THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...1.0359
CONTROL OF EURASIAN MILFOIL ...2.0156
BIOLOGICAL CONTROL - TAMARISK AND OTHER PHREATOPHYTES ...2.0164
STRIPED BASS STUDIES ...2.0193

Biocontrol -other

INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...2.0010
MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...2.0019
POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038
THE USE OF PHEROMONES BY CARP, CYPRINUS CARPIO-RESEARCH ...2.0217

Breeding for Deleterious Char.

SUPPLYING GENETIC MARKER AND INCOMPATIBLE STRAINS OF CULEX PIPIENS ...2.0012
CYTOPLASMIC INCOMPATIBILITY FOR FILARIASIS CONTROL ...2.0013
GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...2.0034
RADIATION CYTOGENETICS OF THE YELLOW-FEVER MOSQUITO, AEDES AEGYPTI ...2.0036
CYTOPLASMIC INHERITANCE AND CONTROL OF CULEX PIPIENS ...2.0041
INTERSPECIFIC COMPETITION AMONG MOSQUITOES ...2.0047
GENETIC STUDIES ON THE CONTROL OF ARBOVIRUS VECTORS ...2.0048
GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055

Competition

CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101
WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104
AQUATIC WEED SUPPRESSION AND CONTROL IN LARGE CANALS ...2.0132
CONTROL AND UTILIZATION OF AQUATIC PLANTS ...2.0157
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...2.0160
CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187
SCHISTOSOME CONTROL BY TREMATODE ANTAGONISM ...2.0270

Disease

TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...2.0007
MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...2.0019
IDENTIFICATION AND CHARACTERIZATION OF MOSQUITO PATHOGENS ...2.0020
BIOLOGY OF MICROORGANISMS OF MOSQUITOES ...2.0022
BIOLOGICAL CONTROL OF INSECTS AFFECTING MAN ...2.0027
INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...2.0029
CULTIVATION OF COELOMOMYCES, A FUNGAL PARASITE OF MOSQUITOES ...2.0031
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS ...2.0033
VIRAL PATHOGENS ...2.0035
FACTORS AFFECTING ROLE OF MICROORGANISMS IN BIOLOGICAL CONTROL OF INSECT PESTS ...2.0037
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043
MODE OF ACTION OF A NEW FUNGAL PATHOGEN OF MOSQUITOES ...2.0070
POTENTIAL OF COELOMOMYCES FOR CONTROLLING MOSQUITOES ...2.0071
STUDIES ON SOME FUNGAL PARASITES OF MOSQUITOES ...2.0072
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...2.0079
ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089
BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...2.0121
BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...2.0122
A CRITICAL TEST OF METHODS FOR ISOLATION OF VIRUSES FOR USE IN CONTROL OF NUISANCE ALGAE ...2.0133
NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135
EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...2.0170
LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...2.0184
NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188
SCHISTOSOME CONTROL BY TREMATODE ANTAGONISM ...2.0270
THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER ...4.0004
THE NUTRITION AND BEHAVIOR OF MOSQUITOES ...4.0033
MOSQUITOES OF MALAYSIA ...4.0060

Life Cycle Disruption of Pest

INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...2.0280

Parasites

ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001
BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...2.0006
BIOLOGICAL CONTROL OF INSECTS AFFECTING MAN ...2.0027
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043
FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...2.0053
BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057
INSECT SURVEY OF MONTANA ...2.0058
INSECTS AFFECTING MAN AND ANIMALS ...2.0081
BIOLOGICAL FACTORS IN THE MANAGEMENT OF LAKE FLIES ...2.0088
EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...2.0170
SCHISTOSOME CONTROL BY TREMATODE ANTAGONISM ...2.0270
THE BIOLOGY AND CONTROL OF THE SNAIL INTERMEDIATE HOST OF SCHISTOSOMES ...2.0276
BIOLOGY AND BIOLOGICAL CONTROL OF SCHISTOSOMIASIS ...2.0277
THE NUTRITION AND BEHAVIOR OF MOSQUITOES ...4.0033
DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053
AQUATIC & SEMI-AQUATIC DIPTERA STUDIES ...4.0073

Predators

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...1.0249
ECOLOGICAL STUDIES OF WILDLIFE MANAGEMENT PRACTICES ...1.0327
ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001
BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...2.0006
BIOLOGY AND CONTROL OF MOSQUITOES IN IRRIGATED AND WATER MANAGEMENT AREAS ...2.0011
BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES ...2.0014

MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...2.0019

BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...2.0040

EFFECT OF PREDATORS AND PARASITES ON MOSQUITO BREEDING IN LOUISIANA ...2.0045

CONTROL OF BLACK FLIES AND MOSQUITOES IN MAINE ...2.0046

INSECTS AFFECTING MAN ...2.0068

EMERGENCY INSECT CONTROL ...2.0076

DISTRIBUTION AND ECOLOGY OF PENNSYLVANIA SALAMANDERS ...2.0080

BIOLOGICAL FACTORS IN THE MANAGEMENT OF LAKE FLIES ...2.0088

AQUATIC PLANT CONTROL BY HERBIVOROUS AMUR FISH ...2.0092

CHEMICAL CONTROL OF WEEDS IN PONDS ...2.0093

SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...2.0095

BIOLOGICAL CONTROL OF WEEDS ...2.0099

ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0117

SOUTHEASTERN BIOLOGICAL CONTROL OF WEEDS INVESTIGATIONS ...2.0120

MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...2.0124

THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...2.0130

EXPERIMENTAL INTRODUCTION OF EXOTIC FRESHWATER FISHES ...2.0131

NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135

AQUATIC WEED CONTROL BY POND FISHES ...2.0139

INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...2.0144

INSECTS ASSOCIATED WITH AQUATIC WEED PESTS OF FOREIGN ORIGIN ...2.0145

EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...2.0170

NATURAL ENEMIES OF EURASIAN WATERMILFOIL IN PAKISTAN ...2.0173

THE CRAYFISH (ORCONECTES CAUSEYI) AS A BIOLOGICAL CONTROL OF AQUATIC VEGETATION ...2.0175

METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186

NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188

BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...2.0269

BIOLOGICAL STUDIES OF MALACOPHAGOUS DIPTERA ...2.0282

EUROPEAN SCIOMYZIDAE ...2.0283

STUDY THE BIOLOGY OF A GROUP OF SNAIL-KILLING FLIES ...2.0287

ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

BIOLOGY AND CONTROL OF TERRESTIAL MOLLUSKS ...2.0289

MOSQUITOES OF MALAYSIA ...4.0060

AQUATIC & SEMI-AQUATIC DIPTERA STUDIES ...4.0073

Sterile Release

CYTOPLASMIC INCOMPATIBILITY FOR FILARIASIS CONTROL ...2.0013

CONTROL OF CULEX NIGRIPALPUS BY STERILITY METHODS ...2.0032

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS ...2.0033

GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...2.0034

RADIATION CYTOGENETICS OF THE YELLOW-FEVER MOSQUITO, AEDES AEGYPTI ...2.0036

MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085

Biological Water Properties

DETERMINATION OF THE EFFECTS OF A FERTILIZER-INDUCED PLANKTON TURBIDITY, SUPPLEMENTED BY HERBICIDES, ON SUBMERGED AQUATIC PLANTS ...2.0137

FIELD INVESTIGATION OF THE SUBMERSED AQUATIC ENVIRONMENT ...4.0003

Bird Studies

Censusing

FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...2.0142

Endangered Species

INSECTICIDES AND EGG-SHELL DEPOSITION ...1.0368

Food Supply

SELECTED PESTICIDES VS. WILDLIFE IN AQUATIC ENVIRONMENTS ...1.0325

EVALUATION OF MANAGEMENT PRACTICES ON THE STATE-OWNED WILDLIFE AREAS ...2.0103

FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...2.0142

FOREST AND FARM GAME HABITAT; FISH POND ...2.0143

Game Reserves & Preserves

EFFECTS OF A SNAPPING TURTLE POPULATION ON THE WATERFOWL PRODUCTIVITY OF A MARSH ...2.0292

Management -other

EVALUATION OF MANAGEMENT PRACTICES ON THE STATE-OWNED WILDLIFE AREAS ...2.0103

Mark, Tag or Capture

ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...2.0083

Nesting Sites

SELECTED PESTICIDES VS. WILDLIFE IN AQUATIC ENVIRONMENTS ...1.0325

EFFECTS OF A SNAPPING TURTLE POPULATION ON THE WATERFOWL PRODUCTIVITY OF A MARSH ...2.0292

Pathology

THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...1.0359

DIAGNOSIS OF DISEASES IN WILDLIFE ...3.0134

Birds

Anseriformes

THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...1.0359

PESTICIDE LEVELS IN BIRDS WINTERING ON LAKE MICHIGAN ...1.0367

EVALUATION OF MANAGEMENT PRACTICES ON THE STATE-OWNED WILDLIFE AREAS ...2.0103

THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...2.0130

EVALUATION OF WATERFOWL PREDATOR CONTROL METHODS ...2.0272

INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...2.0280

EFFECTS OF A SNAPPING TURTLE POPULATION ON THE WATERFOWL PRODUCTIVITY OF A MARSH ...2.0292

Birds -nonspecific

FACTORS AFFECTING PESTICIDE TOXICITY ...1.0255

FISHERY RESOURCES PROGRAM ...1.0317

INVESTIGATION OF MEANS FOR CONTROLLED SELF-DESTRUCTION OF PESTICIDES ...**1.0323**

CHEMICAL BIOCIDES IN LAKES ...**1.0364**

THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...**1.0365**

ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...**2.0083**

INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...**2.0087**

DEVELOPMENTS OF METHODS RELATED TO TESTING OF FISH CONTROL AGENTS BIOCHEMICAL METHOD FOR SEXING FISH ...**2.0248**

Charadriiformes

PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...**1.0163**

REPRODUCTIVE PERFORMANCE OF FISH-EATING BIRDS IN NORTHERN CALIFORNIA ...**1.0320**

INSECTICIDES AND EGG-SHELL DEPOSITION ...**1.0368**

Ciconiiformes

REPRODUCTIVE PERFORMANCE OF FISH-EATING BIRDS IN NORTHERN CALIFORNIA ...**1.0320**

SELECTED PESTICIDES VS. WILDLIFE IN AQUATIC ENVIRONMENTS ...**1.0325**

POSSIBLE BIRD TRANSMISSION OF 'MYXOSOMA CEREBRALIS' ...**3.0105**

Colymbiformes

CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...**1.0235**

Falconiformes

THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...**1.0297**

REPRODUCTIVE PERFORMANCE OF FISH-EATING BIRDS IN NORTHERN CALIFORNIA ...**1.0320**

SELECTED PESTICIDES VS. WILDLIFE IN AQUATIC ENVIRONMENTS ...**1.0325**

INSECTICIDES AND EGG-SHELL DEPOSITION ...**1.0368**

Galliformes

LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...**1.0212**

CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...**1.0235**

CONTROL OF COMMON HOUSEFLY ...**2.0005**

Passeriformes

CLASSIFICATION, BIONOMICS, ECOLOGY CONTROL OF FOREST INSECTS (OTHER THAN SCOLYTIDAE) IN CAL. ...**1.0321**

SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...**2.0278**

SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...**2.0279**

Pelecaniformes

REPRODUCTIVE PERFORMANCE OF FISH-EATING BIRDS IN NORTHERN CALIFORNIA ...**1.0320**

SELECTED PESTICIDES VS. WILDLIFE IN AQUATIC ENVIRONMENTS ...**1.0325**

Blood Plasma and Serum

EFFECTS OF PESTICIDES ON MARINE ANIMALS ...**1.0243**

THE UPTAKE OF AND BIOLOGICAL RESPONSES TO AROCLORS IN CHANNEL CATFISH ...**1.0267**

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0269**

SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0273**

CHARACTERIZATION OF ESTERASE(S) PRESENT IN FISH BLOOD ...**1.0276**

PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...**1.0289**

PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...**1.0290**

MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...**1.0292**

EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...**2.0234**

DEVELOPMENTS OF METHODS RELATED TO TESTING OF FISH CONTROL AGENTS BIOCHEMICAL METHOD FOR SEXING FISH ...**2.0248**

THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...**2.0252**

THE EFFECTS OF THANITE ON THE INORGANIC BLOOD CHEMISTRIES OF FISHES ...**2.0253**

THE EFFECTS OF THANITE ON THE ACID-BASE BALANCE IN THE BLOOD OF FISHES ...**2.0254**

EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH ...**2.0260**

HISTOPATHOLOGY OF SALMONID FISHES - BACTERIAL RED-MOUTH DISEASE HISTOPATHOGENESIS OF RAINBOW TROUT (SALMON GAIRDNERI) ...**3.0093**

HISTOPATHOLOGY OF SALMONID FISHES: DIAGNOSIS ...**3.0095**

IMMUNODIAGNOSIS OF WHIRLING DISEASE (MYXOSOMA CEREBRALIS) ...**3.0103**

MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...**3.0106**

ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...**4.0044**

BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...**4.0045**

COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...**4.0049**

BIONOMICS OF SELECTED NORTH AMERICAN CULICINE MOSQUITOES ...**4.0054**

JAPANESE ENCEPHALITIS ON GUAM ...**4.0062**

PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA ...**4.0074**

Boron

ATOMIC ABSORPTION ANALYSIS OF PHOSPHATES IN WATER ...**1.0227**

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...**2.0174**

Bottom Sampling

PESTICIDE KINETICS ...**1.0127**

ARTIFICIAL SUBSTRATE SAMPLERS AS INDICATORS OF WATER QUALITY ...**1.0225**

PESTICIDE CONTAMINATION OF ENVIRONMENT ...**1.0250**

CHEMICAL BIOCIDES IN LAKES ...**1.0364**

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...**2.0168**

VIBRIO PARAHAEMOLYTICUS IN CHESAPEAKE BAY - ISOLATION, INCIDENCE AND PATHOGENICITY ...**3.0026**

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...**4.0018**

EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...**4.0029**

Brackish Water

ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...**1.0153**

DISTRIBUTION OF THE GENUS ERGASILUS (PARASITIC COPEPOD) IN THE SOUTHEASTERN UNITED STATES ...**3.0011**

EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...**3.0119**

Breakwaters

EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029

Bromine -see Also Halogens

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

Browse

FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...2.0142

Calcification, Mineralization

LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...1.0212

California

BIOLOGICAL CONTROL OF WEEDS ...2.0102
OYSTER DISEASE MORTALITY ALONG THE CALIFORNIA COAST ...3.0022
ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...4.0039

Canada

CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0210
DDT IN SNOW FALLEN AT HIGH ALTITUDE SINCE 1950 ...1.0214
SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...2.0207
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082
PATHOLOGY - EPIZOOTIOLOGY ...3.0113
AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...3.0126

Canals

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029
CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101
EFFECT OF COPPER SULFATE ON AQUATIC WEEDS ...2.0108
LABORATORY STUDY OF AQUATIC ENVIRONMENTAL FACTORS AND PLANT GROWTH STAGES ON AQUATIC WEED GROWTH AND HERBICIDAL RESPONSE ...2.0111
AQUATIC PEST CONTROL ...2.0112
BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115
ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0117
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0118
AQUATIC WEED SUPPRESSION AND CONTROL IN LARGE CANALS ...2.0132
INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...2.0144
INSECTS ASSOCIATED WITH AQUATIC WEED PESTS OF FOREIGN ORIGIN ...2.0145
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...2.0178
METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186
NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188
FIELD INVESTIGATION OF THE SUBMERSED AQUATIC ENVIRONMENT ...4.0003

Cancer -see Also Neoplasm

EPIDERMAL PAPILLOMAS ...3.0021
CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045

Carbamates -see Pesticides

FLUORESCENT PROBES IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS FOR WATER POLLUTION ...1.0137
RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146

Carbohydrates

RESPROUTING OF CHAPARRAL ...1.0017
BIOLOGICAL CONTROL OF WEEDS ...2.0099
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0118
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...2.0178
COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...4.0049

Cellulose

ANALYTICAL METHODS FOR PESTICIDES AND PESTICIDE DEGRADATION PRODUCTS ...1.0088
MICROBIOLOGY OF FARM PONDS ...1.0220

Glucose

EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...2.0234
THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...2.0252
COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...4.0049

Glucose Compounds

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269

Glycogen

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082
EVALUATION OF STRESS IN FINGERLING SALMON THERAPEUTIC DRUGS AS STRESS FACTORS ...3.0120
COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...4.0049

Lignin

ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT ...1.0131

Maltose

COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...4.0049

Sugar

EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...2.0165

Trehalose

COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...4.0049

Carbon

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0009
TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...1.0056

Carbon

NEUTRALIZATION OF ROTENONE WITH ACTIVATED CHARCOAL ...2.0223

RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...4.0019

(U) REPELLENCY AND ATTRACTIVENESS OF MAN TO MOSQUITO BITES ...4.0040

Bicarbonates

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

Carbon Dioxide

PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...1.0087

DESIGNING A GLOBAL ENVIRONMENTAL MONITORING SYSTEM ...1.0206

IMPROVING WATER QUALITY BY REMOVAL OF PESTICIDE POLLUTANTS WITH AQUATIC PLANTS ...1.0216

SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0273

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319

AN INVESTIGATION OF THE EFFECTS OF DDT AND OTHER CHLORINATED HYDROCARBONS ON THE GROWTH OF EURYHALINE MICROALGAE ...1.0336

RESPIRATION RATES OF FISH-FOOD INVERTEBRATES EXPOSED TO PESTICIDES ...1.0355

TESTING ADULT ATTRACTION DEVICES AND CHEMOSTERILANTS FOR TABANID FLY CONTROL ...2.0024

SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...2.0028

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS ...2.0033

FACTORS AFFECTING ROLE OF MICROORGANISMS IN BIOLOGICAL CONTROL OF INSECT PESTS ...2.0037

BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...2.0040

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174

EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...2.0234

THE EFFECTS OF THANITE ON THE ACID-BASE BALANCE IN THE BLOOD OF FISHES ...2.0254

EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH ...2.0260

ENVIRONMENTAL STUDY ...3.0030

LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010

POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078

Carbonates

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0273

Carboxylic Acids

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034

Cell Organelles & Organoids

Chromosomes

STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...4.0022

Membranes, Cellular

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...2.0096

INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...4.0027

Mitochondria

BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...1.0303

MOLLUSCICIDES - A CORRELATION OF STRUCTURE VS. ACTIVITY ...2.0291

Plastids

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...2.0096

Cellular Physiology

Action- & Bioelectrical Pot.

NERVE IMPULSE TRANSMISSION CHARACTERISTICS OF ISOLATED FISH-NERVE PREPARATIONS PERFUSED WITH PHYSIOLOGICAL LEVELS OF SELECTED PESTICIDES ...1.0271

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0291

Adsorption & Interface

OCCURRENCE OF FILAMENTOUS SLIMES ORGANISMS BELOW OUTFALLS ...4.0009

INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...4.0027

Cell Injury and Autolysis

IN VITRO POTENCY OF SEVERAL ANTICHOLINESTERASE AGENTS WITH SELECTED MEMBERS OF THE AQUATIC ENVIRONMENT ...1.0348

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...2.0096

EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...2.0165

Environment, Cellular

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...2.0096

EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...2.0165

ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...4.0007

Growth and Differentiation

Growth Rate

THE BIOASSAY OF WATER POLLUTANTS WITH CULTURED MAMMALIAN CELLS ...1.0200

EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...2.0165

Growth Repression

PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN ...1.0213

IN VITRO POTENCY OF SEVERAL ANTICHOLINESTERASE AGENTS WITH SELECTED MEMBERS OF THE AQUATIC ENVIRONMENT ...1.0348

EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...2.0165

Membrane Permeability

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...2.0096

Metabolism, Intracellular

ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT ...1.0131

Autotrophic Metabolism

GROUND AND SURFACE WATERS - POLLUTION ...1.0182

THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM ...**1.0350**

ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...**4.0007**

STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...**4.0022**

Bioenergetics

A PROPOSAL TO STUDY PHOSPHATE INDUCED ALGAL GROWTH IN ORDER TO SUPPRESS OR ELIMINATE THIS PHENOMENA ...**4.0021**

Biosynthesis

EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...**2.0165**

Catabolism and Degradation

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0023**

INTERACTION OF HERBICIDES AND SOIL MICROORGANISMS ...**1.0069**

PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...**1.0087**

ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT ...**1.0131**

MICROBIOLOGY OF FARM PONDS ...**1.0220**

DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...**1.0333**

ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...**1.0339**

INTERCEPTION AND DEGRADATION OF PESTICIDES BY AQUATIC ALGAE ...**1.0363**

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...**3.0029**

Cell Free Metabolism

INHIBITORY EFFECT OF DDT IN ATPASE ASSAY MIXTURES ...**1.0309**

Control of Metabolism

EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...**2.0165**

Nucleic Acids

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...**3.0045**

One-carbon Metabolism

THE EFFECTS OF THANITE ON THE ACID-BASE BALANCE IN THE BLOOD OF FISHES ...**2.0254**

Proteins

PHYSIOLOGY OF ESTUARINE ORGANISMS ...**1.0242**

Respiration

ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT ...**1.0131**

ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...**4.0007**

Model Systems

EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...**2.0165**

Secretory Activity

ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT ...**1.0131**

EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...**2.0165**

Cement, Concrete

INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...**2.0106**

Cereal Crops

ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS ...**1.0049**

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...**1.0081**

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...**1.0192**

INVESTIGATION OF RICE IRRIGATION RETURN FLOWS - TEXAS COASTAL PRAIRIE REGION ...**1.0209**

FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS ...**2.0141**

Channels

PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...**1.0170**

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...**2.0104**

AQUATIC WEED SUPPRESSION AND CONTROL IN LARGE CANALS ...**2.0132**

Chemical Analysis -biological

SEASONAL CHANGES IN ESTERASE ACTIVITY IN FISH AND INVERTEBRATES. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...**1.0275**

DEVELOPMENTS OF METHODS RELATED TO TESTING OF FISH CONTROL AGENTS BIOCHEMICAL METHOD FOR SEXING FISH ...**2.0248**

PATHOLOGY RESEARCH ...**3.0027**

(U) REPELLENCY AND ATTRACTIVENESS OF MAN TO MOSQUITO BITES ...**4.0040**

Chemical Analysis -pesticides

PESTICIDE RESIDUES ON ARIZONA CROPS ...**1.0007**

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0013**

RESPROUTING OF CHAPARRAL ...**1.0017**

ANALYTICAL METHODS FOR PESTICIDES IN SOIL AND WATER ...**1.0018**

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...**1.0019**

MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS ...**1.0028**

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...**1.0038**

REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0046**

REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...**1.0047**

CONTROL OF PESTICIDES IN SOIL AND WATER ...**1.0054**

ANALYSIS OF PESTICIDE RESIDUES ...**1.0058**

PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS ...**1.0063**

FATE OF PESTICIDES ...**1.0064**

SOILS, PESTICIDES AND THE QUALITY OF WATER ...**1.0065**

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0076**

PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...**1.0087**

ANALYTICAL METHODS FOR PESTICIDES AND PESTICIDE DEGRADATION PRODUCTS ...**1.0088**

PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...**1.0090**

FATES OF AGRICULTURAL CHEMICALS IN SOILS ...**1.0092**

SOILS, PESTICIDES, AND THE QUALITY OF WATER ...**1.0103**

INTERFERING SOIL CONSTITUENTS IN DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND WATER ...**1.0109**

IDENTIFICATION AND DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND RUNOFF AND DRAINAGE WATERS. ...**1.0110**

ORGANIC SUBSTANCES IN WATER ...**1.0119**

STUDY OF ELECTROHYDRAULIC WATER TREATMENT ...**1.0121**

EFFLUENT INFLUENCES OF THE MISSISSIPPI RIVER ON THE CHEMISTRY AND BIOLOGY OF ADJACENT OCEAN SYSTEMS ...**1.0130**

FLUORESCENT PROBES IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS FOR WATER POLLUTION ...**1.0137**

THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...**1.0144**
DETECTION AND IDENTIFICATION OF MOLECULAR WATER POLLUTANTS BY LASER RAMAN SPECTROSCOPY ...**1.0151**
GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...**1.0152**
ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...**1.0153**
MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...**1.0160**
PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...**1.0170**
SERVICES FOR THE QUANTITATIVE ANALYSIS OF PESTICIDES IN SEAWATER AND BIOLOGICAL SAMPLES ...**1.0172**
DEVELOPMENT OF FIELD METHODS IN SAMPLING WATER FOR PESTICIDE ANALYSIS ...**1.0173**
PREPARATION OF CHLORINE-36 LABELED ORGANOCHLORINE PESTICIDES AND RELATED COMPOUNDS (PCB'S) ...**1.0174**
DEVELOPMENT OF ANALYTICAL METHODS FOR SELECTED HERBICIDES ...**1.0175**
UPDATING THE 'HANDBOOK OF PROCEDURES FOR PESTICIDE RESIDUE ANALYSIS' - METHODOLOGY IN CHEMICAL ANALYSIS AND SAMPLING ...**1.0176**
RAPID DETECTION OF TOXIC MATERIALS IN WATER ...**1.0180**
GROUND AND SURFACE WATERS - POLLUTION ...**1.0182**
CONCENTRATION AND ANALYSIS OF PESTICIDES AND OTHER RECALCITRANT MOLECULES IN WATER SUPPLIES BY ULTRAFILTRATION ...**1.0185**
AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...**1.0186**
CHROMATOGRAPHIC CONCENTRATION OF PESTICIDES FROM A LARGE MASS OF WATER ...**1.0188**
MICROWAVE-EXCITED EMISSION DETECTOR FOR PESTICIDES AND TRACE METAL ANALYSIS ...**1.0195**
QUANTITATIVE METHODS FOR PESTICIDES IN NATURAL WATERS ...**1.0198**
PESTICIDE LEVELS IN WATER AND WILDLIFE OF REELFOOT LAKE, TENNESSEE ...**1.0208**
LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...**1.0212**
OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...**1.0219**
ATOMIC ABSORPTION ANALYSIS OF PHOSPHATES IN WATER ...**1.0227**
PESTICIDE CONTAMINATION OF ENVIRONMENT ...**1.0250**
MAGNITUDE AND NATURE OF POLYCHLORINATED BIPHENYLS IN COHO SALMON ...**1.0262**
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...**1.0265**
PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...**1.0289**
DEVELOPMENT OF TECHNIQUES FOR IDENTIFICATION OF PESTICIDES AND THEIR METABOLITES BY MASS SPECTROMETRY ...**1.0295**
THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...**1.0297**
THE RELATIONSHIP BETWEEN THE USE OF AGRICULTURAL CHLORINATED HYDROCARBONS AND THEIR RESIDUES IN CHANNEL CATFISH ...**1.0298**
THE UPTAKE OF DIELDRIN IN THE THREE RIDGED NAIAD, AMBLEMA PLICATA ...**1.0301**
PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES ...**1.0306**
SUBLETHAL AMOUNTS OF ORGANIC INSECTICIDES AND FISH ...**1.0313**
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...**1.0319**
THE CHEMISTRY AND TOXICOLOGY OF AGRICULTURAL CHEMICALS ...**1.0322**
INVESTIGATION OF MEANS FOR CONTROLLED SELF-DESTRUCTION OF PESTICIDES ...**1.0323**
PESTICIDES AND WILDLIFE ...**1.0324**
THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...**1.0330**
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...**1.0334**
ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...**1.0339**
TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...**1.0344**
TOXICOLOGY OF PESTICIDES IN THE ENVIRONMENT ...**1.0360**
INSECTICIDES AND EGG-SHELL DEPOSITION ...**1.0368**
AROMATIC SOLVENT AQUATIC HERBICIDES AND EMULSIFYING AGENT TESTING ...**2.0107**
THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...**2.0150**
ROTENOIDS FROM TEPHROSIA VOGELII ...**2.0198**
SEA LAMPREY CONTROL - LAKE HURON CHEMICAL CONTROL ...**2.0204**
LAKE HURON CHEMICAL CONTROL ...**2.0209**
RESIDUES OF MS-222 IN FISH ...**2.0236**
THE DEVELOPMENT OF ANALYTICAL METHODS CAPABLE OF MEASURING TFM RESIDUES IN FISH, WATER, AND OTHER COMPLEX SUBSTRATES ...**2.0238**
ROUTE(S) OF EXCRETION OF QUINALDINE SULFATE, A FISH ANESTHETIC ...**2.0249**

Chemical Analysis -water

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...**1.0032**
PROPERTIES OF TILE DRAINAGE WATER ...**1.0045**
REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...**1.0047**
PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...**1.0052**
ORGANIC SUBSTANCES IN WATER ...**1.0119**
CHEMICAL ANALYSES ...**1.0129**
EFFLUENT INFLUENCES OF THE MISSISSIPPI RIVER ON THE CHEMISTRY AND BIOLOGY OF ADJACENT OCEAN SYSTEMS ...**1.0130**
UPPER ST. JOHNS RIVER BASIN WATER QUALITY, FLORIDA ...**1.0134**
GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...**1.0152**
PESTICIDE MONITORING PROGRAM ...**1.0156**
DEVELOP IN-HOUSE CAPABILITY IN WATER QUALITY TECHNIQUES FOR ANALYSES OF HEAVY METALS, BACTERIA, AND PESTICIDE RESIDUES ...**1.0171**
SERVICES FOR THE QUANTITATIVE ANALYSIS OF PESTICIDES IN SEAWATER AND BIOLOGICAL SAMPLES ...**1.0172**
DEVELOPMENT OF FIELD METHODS IN SAMPLING WATER FOR PESTICIDE ANALYSIS ...**1.0173**
GROUND AND SURFACE WATERS - POLLUTION ...**1.0182**
CONCENTRATION AND ANALYSIS OF PESTICIDES AND OTHER RECALCITRANT MOLECULES IN WATER SUPPLIES BY ULTRAFILTRATION ...**1.0185**
OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...**1.0219**
ATOMIC ABSORPTION ANALYSIS OF PHOSPHATES IN WATER ...**1.0227**
DEVELOPMENT OF TECHNIQUES FOR IDENTIFICATION OF PESTICIDES AND THEIR METABOLITES BY MASS SPECTROMETRY ...**1.0295**
THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...**1.0297**
THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...**2.0150**
CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...**2.0154**
RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...**2.0161**
EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...**2.0168**
BIOLOGY OF THE LARVAL SEA LAMPREY ...**2.0210**
BIOASSAY ...**2.0211**
EUTROPHICATION OF IOWA LAKES AND STREAMS ...**4.0008**
EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...**4.0029**

POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...**4.0078**

Chemical Instrumentation

ORGANIC SUBSTANCES IN WATER ...**1.0119**
FLUORESCENT PROBES IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS FOR WATER POLLUTION ...**1.0137**
CHROMATOGRAPHIC CONCENTRATION OF PESTICIDES FROM A LARGE MASS OF WATER ...**1.0188**
MICROWAVE-EXCITED EMISSION DETECTOR FOR PESTICIDES AND TRACE METAL ANALYSIS ...**1.0195**

Detectors and Sensors

FLUORESCENT PROBES IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS FOR WATER POLLUTION ...**1.0137**
DETECTION AND IDENTIFICATION OF MOLECULAR WATER POLLUTANTS BY LASER RAMAN SPECTROSCOPY ...**1.0151**
MICROWAVE-EXCITED EMISSION DETECTOR FOR PESTICIDES AND TRACE METAL ANALYSIS ...**1.0195**

Chemical Treatment

EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...**1.0041**
PHOTOCHEMICAL METHODS FOR PURIFYING WATER ...**1.0115**
EFFECTIVENESS OF IODINE FOR DISINFECTION OF PUBLIC WATER SUPPLIES & TO DETERMINE PHYSIOLOGICAL EFFECTS ON A HUMAN POPULATION ...**1.0126**
EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...**1.0155**
DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...**1.0183**
EXPERIMENTAL RECLAMATION OF TROUT STREAMS THROUGH CHEMICAL TREATMENT ...**2.0263**

Chlorophyll

GROUND AND SURFACE WATERS - POLLUTION ...**1.0182**
EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...**2.0096**
THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...**2.0150**
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...**3.0082**

Cholesterol

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0269**
SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0273**

Chromatography

ORGANIC SUBSTANCES IN WATER ...**1.0119**
THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...**1.0253**

Column Chromatography

CHROMATOGRAPHIC CONCENTRATION OF PESTICIDES FROM A LARGE MASS OF WATER ...**1.0188**
DEVELOPMENT OF TECHNIQUES FOR IDENTIFICATION OF PESTICIDES AND THEIR METABOLITES BY MASS SPECTROMETRY ...**1.0295**
THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...**1.0297**

Gas Chromatography

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...**1.0019**
PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...**1.0075**
DEVELOPMENT OF ANALYTICAL METHODS FOR SELECTED HERBICIDES ...**1.0175**
PESTICIDE MONITORING ...**1.0217**
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...**1.0224**
SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...**2.0028**
THE DEVELOPMENT OF ANALYTICAL METHODS CAPABLE OF MEASURING TFM RESIDUES IN FISH, WATER, AND OTHER COMPLEX SUBSTRATES ...**2.0238**

Partition Chromatography

CHROMATOGRAPHIC CONCENTRATION OF PESTICIDES FROM A LARGE MASS OF WATER ...**1.0188**

Thin Layer Chromatography

ANALYSIS OF PESTICIDE RESIDUES ...**1.0058**
DEVELOPMENT OF TECHNIQUES FOR IDENTIFICATION OF PESTICIDES AND THEIR METABOLITES BY MASS SPECTROMETRY ...**1.0295**

Clay Minerals

Illite

SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...**1.0181**

Kaolinite

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0013**
SOILS, PESTICIDES, AND THE QUALITY OF WATER ...**1.0103**
SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...**1.0181**

Montmorillonite

CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS ...**1.0042**
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0076**
SOILS, PESTICIDES, AND THE QUALITY OF WATER ...**1.0103**
ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...**1.0106**
SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...**1.0181**

Vermiculite

CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS ...**1.0042**

Climatic Regions

Arid and Desert

BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...**2.0269**
ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...**4.0039**

Humid

AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...**1.0186**

Semi - Arid

MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS ...**1.0011**
REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...**1.0021**

Coagulation Factors

ANALYTICAL METHODS FOR PESTICIDES AND PESTICIDE DEGRADATION PRODUCTS ...1.0088
MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...1.0292

Coastlines - Shorelines

EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...2.0075
ALLEVIATION OF LAKE POLLUTION BY UTILIZATION OF AQUATIC PLANTS FOR NUTRITIONAL, MEDICINAL OR INDUSTRIAL PURPOSES ...2.0152
UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082

Coatings

INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106

Coelenterata

Hydrozoa

BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES ...2.0014

Scyphozoa

SEA NETTLE STUDIES IN CHESAPEAKE BAY, LIFE HISTORY AND ECOLOGY ...2.0273

Cold Storage

LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010

Collections

SURVEY OF INSECT PROBLEMS IN MONTANA ...2.0059
SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...2.0095
NATURAL ENEMIES OF EURASIAN WATERMILFOIL IN PAKISTAN ...2.0173
MOSQUITOES OF MALAYSIA ...4.0060

Colloids

CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS ...1.0042
TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...1.0056
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076
PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...1.0090

Colombia

ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044

Columbia River

RESEARCH VESSEL OPERATIONS ...3.0048
INFECTIOUS DISEASES OF SALMONID FISHES ...3.0049
BIOLOGY OF THE PROTOZOAN PARASITE CERATOMYXA SHASTA ...3.0050
THE RELATIONSHIP OF TEMPERATURE TO DISEASE OF SALMONID FISHES ...3.0051
EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...3.0083
RELATIONSHIP OF TEMPERATURE TO DISEASES OF SALMONID FISH ...3.0116

Compatibility of Pesticides

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0038
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
FACTORS AFFECTING PESTICIDE TOXICITY ...1.0255
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0334
CHEMICAL CONTROL OF WEEDS IN PONDS ...2.0093
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0118
ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

Competition -plants

COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
AQUATIC PLANT CONTROL BY HERBIVOROUS AMUR FISH ...2.0092
WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104
CONTROL AND UTILIZATION OF AQUATIC PLANTS ...2.0157
LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...2.0184
ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024

Complement Fixation Tests

CHARACTERIZATION OF THE INFECTIOUS PANCREATIC NECROSIS (IPN) VIRUS OF TROUT ...3.0031

Computer Methods -general

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034

Connecticut

DISEASES OF FISH ...3.0025

Consultants, Advisory Services

DESIGNING A GLOBAL ENVIRONMENTAL MONITORING SYSTEM ...1.0206

Consumer Attitudes, Awareness,

PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES ...1.0062

Corrosion, Deterioration

INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106
EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...2.0267
EFFECT OF PRETREATMENT MOLDING OF SOUTHERN PINE ON THE PERMANENCE OF THE PRESERVATIVE IN SEAWATER EXPOSURE ...2.0295
MARINE PILING ANALYSIS ...2.0296

Cultural Control of Pests

Cultcontrol -other

FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...2.0142
EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168
EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...2.0170

Cutting Sequence

PROCESSING, CHEMICAL COMPOSITION, AND NUTRITIVE VALUE OF AQUATIC WEEDS ...2.0119
THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...2.0130
ALLEVIATION OF LAKE POLLUTION BY UTILIZATION OF AQUATIC PLANTS FOR NUTRITIONAL, MEDICINAL OR INDUSTRIAL PURPOSES ...2.0152
EUTROPHICATION - EFFECT OF WEED HARVESTING ...2.0169
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...2.0178
IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...2.0181
CHANGES IN WATER ENVIRONMENT RESULTING FROM AQUATIC PLANT CONTROL ...2.0183
NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...4.0015

Nutritional Regulation (host)

AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...1.0343
BIOLOGICAL AND BIOCHEMICAL FACTORS INFLUENCING THE DEVELOPMENT OF LARVAL MOSQUITO POPULATIONS ...2.0052
DETERMINATION OF THE EFFECTS OF A FERTILIZER-INDUCED PLANKTON TURBIDITY, SUPPLEMENTED BY HERBICIDES, ON SUBMERGED AQUATIC PLANTS ...2.0137
EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168
EUTROPHICATION - EFFECT OF WEED HARVESTING ...2.0169
EUTROPHICATION OF IOWA LAKES AND STREAMS ...4.0008
THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0014
TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ...4.0030

Planting Sequence or Method

CONTROL AND UTILIZATION OF AQUATIC PLANTS ...2.0157

Soil Tillage Sequence / Method

CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187

Culture, Tissue, Organ, Cell

Algal Culture

ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...1.0326
STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...4.0022

Axenic Culture

INFLUENCE OF PROTOZOAN ACTIVITY ON HALOGENATED HYDROCARBON RESIDUES - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0349
USE OF CELL CULTURE METHODS TO ATTEMPT TO FOLLOW DEVELOPING STAGES OF SPORES ...3.0062

Cell Lines

THE BIOASSAY OF WATER POLLUTANTS WITH CULTURED MAMMALIAN CELLS ...1.0200
DEVELOPMENT OF NEW FISH CELL LINES ...3.0008
CULTIVATION OF INSECT PHASE OF AVIAN PLASMODIA ...4.0036

Fungal Culture

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082
POTENTIAL OF COELOMOMYCES FOR CONTROLLING MOSQUITOES ...2.0071

Invertebrate Culture

MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...2.0124
COOPERATIVE FISH DISEASE PROJECT ...3.0012
INVESTIGATIONS OF AMEBIASIS IN FISH ...3.0014
USE OF CELL CULTURE METHODS TO ATTEMPT TO FOLLOW DEVELOPING STAGES OF SPORES ...3.0062
ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...4.0069

Tissue Culture

USE OF CELL CULTURE METHODS TO ATTEMPT TO FOLLOW DEVELOPING STAGES OF SPORES ...3.0062

Viral Culture

COOPERATIVE FISH DISEASE PROJECT ...3.0009

Currents -water

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168
EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029

Cyanate & Cyanides

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086
TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005

Data Acquisition

RAPID DETECTION OF TOXIC MATERIALS IN WATER ...1.0180
EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168

Data Analysis

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034
CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0093
WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...1.0162
ASSESSMENT OF LAKE TROUT AND ASSOCIATED SPECIES IN LAKES MICHIGAN AND SUPERIOR ...2.0264

Degradation

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013
BEHAVIOR OF POLLUTANTS IN WATER ...1.0022
ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS ...1.0049
METHODS FOR DISPOSAL OF SPILLED AND UNUSED PESTICIDES ...1.0060
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076
BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083
ANALYTICAL METHODS FOR PESTICIDES AND PESTICIDE DEGRADATION PRODUCTS ...1.0088
SOILS, PESTICIDES, AND THE QUALITY OF WATER ...1.0103
GREEN BAY RESEARCH PROGRAM ...1.0112

METABOLISM OF ENDRIN IN PONDS ...1.0113
STUDY OF ELECTROHYDRAULIC WATER TREATMENT ...1.0121
PESTICIDE KINETICS ...1.0127
DEVELOP EFFECTIVE TREATMENT METHODS FOR HARD PESTIDICIDES ...1.0136
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0141
RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146
DEVELOP EFFECTIVE TREATMENT METHODS FOR HARD PESTICIDES ...1.0197
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0223
METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186
SELECTIVE REMOVAL OF VARIOUS FISH SPECIES WITH ANTIMYCIN ...2.0240
THE EFFICACY OF MONSANTO NO. 51294 AS A FISH TOXICANT (LABORATORY) ...2.0243
THE EFFICACY AND PERSISTENCE OF FORMULATIONS OF ANTIMYCIN ...2.0244
ESTABLISH MINIMUM DOSES OF ANTIMYCIN AND ROTENONE NEEDED FOR TOTAL KILLS OF TARGET FISHES ...2.0247

Biodegradation

ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...1.0153
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0223
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0224
CONSTRUCTION OF PESTICIDES DEGRADABLE BY NORMAL MICROFLORA OF NATURAL WATERS AND SOILS ...1.0331
DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...1.0333

Animal

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0037
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0168
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0305
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319
PESTICIDES AND WILDLIFE ...1.0324
ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...1.0339
EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS ...1.0341
STUDIES ON INSECTICIDE RESISTANCE IN MOSQUITOES ...2.0017
RELATION OF APPLICATION METHODS, CONCENTRATION, AND VOLUME OF INSECTICIDE TO CATTLE INSECT CONTROL ...2.0039
ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089
METABOLISM AND EXCRETION OF TFM ...2.0251

Biodegradation -other

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0038
TOXAPHENE CONTAMINATION - ESTUARINE ECOLOGY ...1.0139
INFLUENCE OF PROTOZOAN ACTIVITY ON HALOGENATED HYDROCARBON RESIDUES - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0349

Micro-organism

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034
HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...1.0035
FATE OF PESTICIDES ...1.0064
MICROBIOLOGY OF FARM PONDS ...1.0220
TERMINAL RESIDUES OF CHLORINATED HYDROCARBON PESTICIDES IN LAKE MICHIGAN AND ASSOCIATED TRIBUTARIES ...1.0222
CONSTRUCTION OF PESTICIDES DEGRADABLE BY NORMAL MICROFLORA OF NATURAL WATERS AND SOILS ...1.0331
BIODEGRADATION OF PESTICIDES IN A FRESHWATER ECOSYSTEM - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0352
INTERCEPTION AND DEGRADATION OF PESTICIDES BY AQUATIC ALGAE ...1.0363
ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089

Plant

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0037
REDUCTION OF PESTICIDE RESIDUE HAZARDS ...1.0040
INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0043
FATE OF PESTICIDES ...1.0064
FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL ...1.0077
FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095
IMPROVING WATER QUALITY BY REMOVAL OF PESTICIDE POLLUTANTS WITH AQUATIC PLANTS ...1.0216
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0228
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319
PESTICIDES AND WILDLIFE ...1.0324
BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162
STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...4.0022

Chemical Degradation

DEVELOPMENT OF A TECHNIQUE FOR THE CONTROLLED SELF-DESTRUCTION OF FIELD-APPLIED DDT ...1.0014
RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019
DISPOSITION OF PESTICIDES IN THE SOIL ...1.0031
FATE OF PESTICIDES ...1.0064
TOXAPHENE CONTAMINATION - ESTUARINE ECOLOGY ...1.0139
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0223
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0224
INVESTIGATION OF MEANS FOR CONTROLLED SELF-DESTRUCTION OF PESTICIDES ...1.0323
PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...1.0358

Physical Degradation

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023
REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0046
FATE OF PESTICIDES ...1.0064
FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...1.0089
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0091
PHOTOCHEMICAL METHODS FOR PURIFYING WATER ...1.0115
STUDY OF ELECTROHYDRAULIC WATER TREATMENT ...1.0121
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319

Thermal Decomposition

SOILS, PESTICIDES, AND THE QUALITY OF WATER ...1.0103

Deguelin

ROTENOIDS FROM TEPHROSIA VOGELII ...2.0198

Delaware River

DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...1.0184

Deltas

WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...1.0050

GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152

Destratification

ALGAE CONTROL BY ARTIFICIAL MIXING IN LAKE COCHITUATE ...2.0149

EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...2.0171

RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY ...4.0002

Developmental Biology - Animal

EFFECT OF ENDRIN ON EGG-SPERM FORMATION AND EMBRYONIC DEVELOPMENT ...1.0229

EFFECTS OF PESTICIDES ON MARINE ANIMALS ...1.0244

SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...2.0207

BIOLOGY OF THE LARVAL SEA LAMPREY ...2.0210

STUDY OF THE INCIDENCE AND LIFE CYCLES OF MYXOSPORIDIAL INFECTIONS IN WARM WATER FISHES (REVISED) ...3.0020

ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...3.0052

Dewatering

IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION ...2.0182

Dicumarol

TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005

Discharge -water

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029

AN EVALUATION OF THE INSECTICIDE 'SEVIN' AS A WATERSHED POLLUTANT ...1.0067

UPPER ST. JOHNS RIVER BASIN WATER QUALITY, FLORIDA ...1.0134

PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...1.0199

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...1.0328

DEVELOPMENT OF ACCURATE CHEMICAL INTRODUCTION TECHNIQUES ...2.0223

OCCURRENCE OF FILAMENTOUS SLIMES ORGANISMS BELOW OUTFALLS ...4.0009

Dispersion -water

DEVELOPMENT OF RHODAMINE-B DYE TO TRACE FLOW AND DISPERSION PATTERNS IN STREAMS AS AN ADJUNCT TO TREATING STREAMS WITH FISH-CONTROL CHEMICALS ...2.0245

Distillation

Vacuum Distillation

ORGANIC SUBSTANCES IN WATER ...1.0119

Drainage

NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0027

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029

PROPERTIES OF TILE DRAINAGE WATER ...1.0045

ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS ...1.0049

SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072

NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073

QUALITY OF IRRIGATION RETURN FLOW ...1.0102

IDENTIFICATION AND DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND RUNOFF AND DRAINAGE WATERS. ...1.0110

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161

GROUND AND SURFACE WATERS - POLLUTION ...1.0182

QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0192

ILLINOIS LAWS AFFECTING AGRICULTURE ...1.0332

INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025

EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE I ...2.0073

EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...2.0075

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104

Drawdown

SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072

WATERLEVEL MANAGEMENT ON IMPOUNDMENTS OF LOW QUALITY SOILS ...2.0163

Drift -pesticide

PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES ...1.0062

Drying Equipment

IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION ...2.0182

Dyes

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183

EARLY SQUAMATION OF BLUEGILL (LEPOMIS MACROCHIRUS) AND FATHEAD MINNOWS (PIMEPHALES PROMELAS) EXPOSED TO AROCLORS ...**1.0286**

BIOLOGICAL AND BIOCHEMICAL FACTORS INFLUENCING THE DEVELOPMENT OF LARVAL MOSQUITO POPULATIONS ...**2.0052**

PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...**2.0105**

Echinodermata

Asteroidea

NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...**2.0271**

Echinoidea

EFFECTS OF PESTICIDES ON MARINE ANIMALS ...**1.0244**

Ecology - Animal

Applied Ecology

Biological Control

BIOLOGY AND BIOLOGICAL CONTROL OF SCHISTOSOMIASIS ...**2.0277**

Pollution Effects

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...**1.0133**

EFFECTS OF WATER POLLUTION ON ZOOPLANKTON ...**1.0207**

BEHAVIOR OF ESTUARINE ANIMALS ...**1.0240**

TOXICITY OF POLLUTANTS TO STRIPED BASS ...**1.0251**

RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...**1.0256**

LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES ...**1.0258**

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...**1.0260**

THE EFFECT OF DIELDRIN ON SURVIVAL AND DEVELOPMENT OF FISH EGGS ...**1.0300**

THE UPTAKE OF DIELDRIN IN THE THREE RIDGED NAIAD, AMBLEMA PLICATA ...**1.0301**

ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...**1.0326**

MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS ...**1.0338**

BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...**1.0342**

ENVIRONMENTAL TOXICOLOGY OF PESTICIDES ...**1.0361**

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...**2.0104**

EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...**3.0089**

Aquatic Ecology

ESTUARINE ECOSYSTEMS ...**1.0128**

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...**1.0133**

RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS ...**1.0138**

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...**1.0161**

PRESTICIDE INPUTS AND LEVELS IN MINNESOTA WATERS OF THE LAKE SUPERIOR BASIN ...**1.0167**

TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE ...**1.0201**

FISHERIES UNIT ...**1.0203**

PESTICIDES RESEARCH ...**1.0232**

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...**1.0236**

BEHAVIOR OF ESTUARINE ANIMALS ...**1.0240**

PHYSICAL AND CHEMICAL FACTORS AFFECTING FISH ...**1.0246**

RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...**1.0256**

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...**1.0260**

EFFECTS OF PARATHION AND MALATHION ON WARM-WATER FISH PONDS ...**1.0283**

THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...**1.0297**

THE UPTAKE OF DIELDRIN IN THE THREE RIDGED NAIAD, AMBLEMA PLICATA ...**1.0301**

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...**1.0304**

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...**1.0305**

ECOLOGICAL STUDIES OF WILDLIFE MANAGEMENT PRACTICES ...**1.0327**

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...**1.0328**

THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...**1.0330**

MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS ...**1.0338**

ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...**1.0339**

FARM FISH POND MANAGEMENT ...**1.0340**

BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...**1.0342**

DETERMINATION OF DIGESTION RATES FOR TROUT ...**1.0346**

INFLUENCE OF PROTOZOAN ACTIVITY ON HALOGENATED HYDROCARBON RESIDUES - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0349**

INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0351**

BIODEGRADATION OF PESTICIDES IN A FRESHWATER ECOSYSTEM - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0352**

STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970 ...**1.0354**

EVALUATION OF GIZZARD SHAD AS A FORAGE FISH ...**1.0356**

THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...**1.0359**

PHARMACOLOGICAL AND ECOLOGICAL EFFECTS OF PESTICIDES ...**1.0362**

STUDY ON THE EFFECTS OF FISH TOXICANTS ANTIMYCIN A AND ROTENONE ON POND COMMUNITIES ...**1.0366**

BIOLOGY AND CONTROL OF MOSQUITOES IN IRRIGATED AND WATER MANAGEMENT AREAS ...**2.0011**

TESTING ADULT ATTRACTION DEVICES AND CHEMOSTERILANTS FOR TABANID FLY CONTROL ...**2.0024**

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...**2.0043**

BIOLOGICAL AND BIOCHEMICAL FACTORS INFLUENCING THE DEVELOPMENT OF LARVAL MOSQUITO POPULATIONS ...**2.0052**

BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS ...**2.0054**

SURVEY OF INSECT PROBLEMS IN MONTANA ...**2.0059**

WATER MANAGEMENT IN MOSQUITO IMPOUNDMENTS ...**2.0064**

MOSQUITO CONTROL IN UPLAND SWAMPS ...**2.0065**

CONTROLLING MOSQUITOES ON HAYING MEADOWS ...**2.0066**

EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE 1 ...**2.0073**

EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...**2.0075**

DISTRIBUTION AND ECOLOGY OF PENNSYLVANIA SALAMANDERS ...**2.0080**

BIOLOGICAL FACTORS IN THE MANAGEMENT OF LAKE FLIES ...**2.0088**

ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0117
MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...2.0124
THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...2.0130
EXPERIMENTAL INTRODUCTION OF EXOTIC FRESHWATER FISHES ...2.0131
AQUATIC WEED CONTROL BY POND FISHES ...2.0139
THE CRAYFISH (ORCONECTES CAUSEYI) AS A BIOLOGICAL CONTROL OF AQUATIC VEGETATION ...2.0175
SMALL IMPOUNDMENT STOCKING ...2.0190
HAUL SEINE STUDY ...2.0192
STRIPED BASS STUDIES ...2.0193
SQUAWFISH STUDIES--ST. JOE RIVER, IDAHO ...2.0196
STUDY OF THE SEA LAMPREY IN LOVE LAKE ...2.0200
JO-MARY POND RECLAMATION ...2.0201
ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202
SEA LAMPREY CONTROL - LAKE MICHIGAN CHEMICAL CONTROL ...2.0203
SEA LAMPREY CONTROL - LAKE HURON CHEMICAL CONTROL ...2.0204
LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...2.0205
SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...2.0207
SEA LAMPREY CONTROL - ASSESSMENT METHODS ...2.0208
BIOLOGY OF THE LARVAL SEA LAMPREY ...2.0210
EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP, SOFT-WATER LAKES ...2.0213
THE INTERACTION OF THE WALLEYE AND WHITE SUCKER IN THE FISH POPULATION OF SOFT WATER LAKE IN NORTHEASTERN MINNESOTA ...2.0215
EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP SOFTWATER LAKES ...2.0216
RELATION OF LAMPREY EELS TO EXISTING SALMONID STOCKS IN CAYUGA LAKE ...2.0219
PRE-LAMPREY CONTROL INVENTORY OF FISH STOCKS ...2.0222
AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO ...2.0227
MERIDIAN STATE PARK LAKE CRAPPIE REMOVAL EXPERIMENT ...2.0231
POPULATION DYNAMICS - LAKE TROUT ...2.0235
EXPERIMENTAL RECLAMATION OF TROUT STREAMS THROUGH CHEMICAL TREATMENT ...2.0263
ASSESSMENT OF LAKE TROUT AND ASSOCIATED SPECIES IN LAKES MICHIGAN AND SUPERIOR ...2.0264
BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...2.0269
NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...2.0271
SEA NETTLE STUDIES IN CHESAPEAKE BAY, LIFE HISTORY AND ECOLOGY ...2.0273
EFFECTS OF WATER EXCHANGE AND BLUE CRAB CONTROL ON SHRIMP PRODUCTION IN LOUISIANA SALTMARSH IMPOUNDMENTS ...2.0275
SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...2.0279
CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER ...2.0290
DISTRIBUTION OF THE GENUS ERGASILUS (PARASITIC COPEPOD) IN THE SOUTHEASTERN UNITED STATES ...3.0011
IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...3.0018
LIMNOLOGICAL, ICHTHYOLOGICAL, AND PARASITOLOGICAL INVESTIGATIONS ON ARKANSAS RESERVOIRS IN RELATION TO WATER QUALITY ...3.0019
STUDY OF THE INCIDENCE AND LIFE CYCLES OF MYXOSPORIDIAL INFECTIONS IN WARM WATER FISHES (REVISED) ...3.0020
OYSTER DISEASE MORTALITY ALONG THE CALIFORNIA COAST ...3.0022
DISEASES OF FISH ...3.0025
SHELLFISH MORTALITY - CHESAPEAKE BAY ...3.0033
PACIFIC OYSTER MORTALITY STUDIES ...3.0034
REFINEMENT OF MANAGEMENT TECHNIQUES FOR STREAM TROUT LAKES ...3.0035
EXPERIMENTAL CONTROL OF NEASCUS IN SMALL TROUT LAKES ...3.0036
INVENTORY OF WATERS OF THE PROJECT AREA ...3.0039
PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...3.0047
RESEARCH VESSEL OPERATIONS ...3.0048
ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...3.0052
MARINE FISHERIES - SYMBIOSIS AND PARASITISM - RESEARCH ...3.0055
IMPACT OF CERATOMYXA IN CENTRAL OREGON SALMONID POPULATIONS ...3.0057
MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...3.0060
MARINE FISH-CULTURE PATHOLOGY ...3.0070
WALLEYE AND NORTHERN PIKE STUDY ...3.0072
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082
EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...3.0083
MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...3.0106
PATHOLOGY - EPIZOOTIOLOGY ...3.0113
EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029
ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...4.0039
OCCURRENCE AND BIONOMICS OF BLOODSUCKING MIDGES (DIPTERA: CERATOPOGONIDAE) IN IOWA ...4.0056
INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS. WESTERN KENYA ...4.0059
ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...4.0069
AQUATIC & SEMI-AQUATIC DIPTERA STUDIES ...4.0073
RENOVATION OF TROUT STREAMS ...4.0076
LIFE HISTORY OF ST. JOE RIVER CUTTHROAT TROUT ...4.0077
POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078
A STUDY OF THE INTERACTION OF THREE SPECIES OF BULLHEAD AND ASSOCIATED GAME FISH SPECIES IN A SINGLE LAKE ...4.0079
FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES ...4.0080
GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081
LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN ...4.0082
REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES ...4.0083
SURVEYS FOR PANFISH CONTROL STUDIES ...4.0086

Dispersion -animal

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133
PESTICIDES RESEARCH ...1.0232
THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...1.0297
BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342
CONTROL OF BLACK FLIES AND MOSQUITOES IN MAINE ...2.0046
BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS ...2.0054
ABUNDANCE, DISTRIBUTION AND CONTROL OF MISCELLANEOUS INSECTS, AFFECTING LIVESTOCK ...2.0056
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...2.0079

DISTRIBUTION AND ECOLOGY OF PENNSYLVANIA SALAMANDERS ...2.0080
INSECTS AFFECTING MAN AND ANIMALS ...2.0081
BIOLOGICAL CONTROL OF WEEDS ...2.0099
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0129
STUDY OF THE SEA LAMPREY IN LOVE LAKE ...2.0200
SEA LAMPREY CONTROL - LAKE HURON CHEMICAL CONTROL ...2.0204
BIOLOGY OF THE LARVAL SEA LAMPREY ...2.0210
PRE-LAMPREY CONTROL INVENTORY OF FISH STOCKS ...2.0222
SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...2.0278
SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...2.0279
BIOLOGY OF THE PROTOZOAN PARASITE CERATOMYXA SHASTA ...3.0050
MARINE FISH-CULTURE PATHOLOGY ...3.0070
WALLEYE AND NORTHERN PIKE STUDY ...3.0072
EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...3.0083
EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...3.0089
MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...3.0106
SPAWNING AND REARING OF MARINE FISH ...3.0110
MOSQUITOES OF MIDDLE AMERICA ...4.0037
MOSQUITOES OF MIDDLE AMERICA ...4.0038
ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...4.0039
POPULATION DYNAMICS OF MOSQUITOES IN FLORIDA ...4.0048
MOSQUITOES OF THE NEW GUINEA AREA ...4.0050
INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...4.0059
INSECTS AS VECTORS OF DISEASES OF MILITARY IMPORTANCE IN ETHIOPIA THEIR ECOLOGY AND CONTROL ...4.0067
RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070
LIFE HISTORY OF ST. JOE RIVER CUTTHROAT TROUT ...4.0077
FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES ...4.0080

Environmental Ecology

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161
THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...1.0253
CHEMICAL BIOCIDES IN LAKES ...1.0364
BIOLOGY OF THE LARVAL SEA LAMPREY ...2.0210
NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...2.0271
EXPERIMENTS TO RE-ESTABLISH HISTORICAL OYSTER SEED GROUNDS AND TO CONTROL THE SOUTHERN OYSTER DRILL ...2.0274
IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...3.0018
LIMNOLOGICAL, ICHTHYOLOGICAL, AND PARASITOLOGICAL INVESTIGATIONS ON ARKANSAS RESERVOIRS IN RELATION TO WATER QUALITY ...3.0019
OYSTER DISEASE MORTALITY ALONG THE CALIFORNIA COAST ...3.0022
DISEASES OF FISH ...3.0025
ENVIRONMENTAL STUDY ...3.0030
INVENTORY OF WATERS OF THE PROJECT AREA ...3.0039
MARINE FISHERIES - SYMBIOSIS AND PARASITISM - RESEARCH ...3.0055
MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...3.0060
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082
EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...3.0083
LAKE SUPERIOR PERIPHYTON IN RELATION TO WATER QUALITY ...4.0017
GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081
LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN ...4.0082
SURVEYS FOR PANFISH CONTROL STUDIES ...4.0086

Habitat Studies -animal

MAYFLY DISTRIBUTION AS A WATER QUALITY INDEX ...1.0169
FISHERIES UNIT ...1.0203
RESEARCH STUDY ON THE EFFECTS OF POLLUTION ON SUB-TROPICAL FISH AND CRUSTACEANS ...1.0237
THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...1.0253
PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260
SELECTED PESTICIDES VS. WILDLIFE IN AQUATIC ENVIRONMENTS ...1.0325
ECOLOGICAL STUDIES OF WILDLIFE MANAGEMENT PRACTICES ...1.0327
BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES ...2.0014
TESTING ADULT ATTRACTION DEVICES AND CHEMOSTERILANTS FOR TABANID FLY CONTROL ...2.0024
BIOLOGY AND ECOLOGY OF SALT-MARSH MOSQUITOES OF LOUISIANA ...2.0042
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043
BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS ...2.0054
SURVEY OF INSECT PROBLEMS IN MONTANA ...2.0059
WATER MANAGEMENT IN MOSQUITO IMPOUNDMENTS ...2.0064
MOSQUITO CONTROL IN UPLAND SWAMPS ...2.0065
INSECTS AFFECTING MAN ...2.0068
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...2.0075
DISTRIBUTION AND ECOLOGY OF PENNSYLVANIA SALAMANDERS ...2.0080
INSECTS AFFECTING MAN AND ANIMALS ...2.0081
FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...2.0142
FOREST AND FARM GAME HABITAT; FISH POND ...2.0143
EXPERIMENTAL USE OF PESTICIDES FOR FISHERIES MANAGEMENT PURPOSES ...2.0189
SOUAWFISH STUDIES--ST. JOE RIVER, IDAHO ...2.0196
SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...2.0278
SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...2.0279
EUROPEAN SCIOMYZIDAE ...2.0283
INVENTORY OF WATERS OF THE PROJECT AREA ...3.0039
WALLEYE AND NORTHERN PIKE STUDY ...3.0072
EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029
ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...4.0039
BIOLOGICAL STUDIES OF CULICOIDES AND THEIR CONTROL IN THE CANAL ZONE ...4.0043
ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044
MOSQUITOES OF THE NEW GUINEA AREA ...4.0050
OCCURRENCE AND BIONOMICS OF BLOODSUCKING MIDGES (DIPTERA: CERATOPOGONIDAE) IN IOWA ...4.0056
RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070
LIFE HISTORY OF ST. JOE RIVER CUTTHROAT TROUT ...4.0077
A STUDY OF THE INTERACTION OF THREE SPECIES OF BULLHEAD AND ASSOCIATED GAME FISH SPECIES IN A SINGLE LAKE ...4.0079

FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES ...**4.0080**

Interbiotic Relationship

BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS ...**2.0054**

THE INTERACTION OF THE WALLEYE AND WHITE SUCKER IN THE FISH POPULATION OF SOFT WATER LAKE IN NORTHEASTERN MINNESOTA ...**2.0215**

VIBRIO PARAHAEMOLYTICUS IN CHESAPEAKE BAY - ISOLATION, INCIDENCE AND PATHOGENICITY ...**3.0026**

Behavioral Ecology

BEHAVIOR OF ESTUARINE ANIMALS ...**1.0240**

SELECTED PESTICIDES VS. WILDLIFE IN AQUATIC ENVIRONMENTS ...**1.0325**

DISTRIBUTION AND ECOLOGY OF PENNSYLVANIA SALAMANDERS ...**2.0080**

STUDIES OF SHARK REPELLENTS AND OTHER ANTISHARK MEASURES ...**2.0191**

NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...**2.0271**

BIOLOGY AND CONTROL OF TERRESTRIAL MOLLUSCS ...**2.0281**

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...**3.0029**

FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES ...**4.0080**

Competition

INTERSPECIFIC COMPETITION AMONG MOSQUITOES ...**2.0047**

SQUAWFISH CONTROL IN CASCADE RESERVOIR ...**2.0195**

EXPERIMENTAL ESTABLISHMENT OF MONOSPECIFIC WALLEYE POPULATIONS AS A MANAGEMENT MEASURE FOR SMALL WARMWATER LAKES IN NORTHERN MINNESOTA ...**2.0214**

EXPERIMENTAL RECLAMATION OF TROUT STREAMS THROUGH CHEMICAL TREATMENT ...**2.0263**

SCHISTOSOME CONTROL BY TREMATODE ANTAGONISM ...**2.0270**

NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...**2.0271**

ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE ...**4.0031**

A STUDY OF THE INTERACTION OF THREE SPECIES OF BULLHEAD AND ASSOCIATED GAME FISH SPECIES IN A SINGLE LAKE ...**4.0079**

Predation

DETERMINATION OF DIGESTION RATES FOR TROUT ...**1.0346**

EVALUATION OF GIZZARD SHAD AS A FORAGE FISH ...**1.0356**

ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...**2.0202**

RELATION OF LAMPREY EELS TO EXISTING SALMONID STOCKS IN CAYUGA LAKE ...**2.0219**

AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO ...**2.0227**

POPULATION DYNAMICS - LAKE TROUT ...**2.0235**

BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...**2.0269**

SCHISTOSOME CONTROL BY TREMATODE ANTAGONISM ...**2.0270**

NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...**2.0271**

EVALUATION OF WATERFOWL PREDATOR CONTROL METHODS ...**2.0272**

EXPERIMENTS TO RE-ESTABLISH HISTORICAL OYSTER SEED GROUNDS AND TO CONTROL THE SOUTHERN OYSTER DRILL ...**2.0274**

EFFECTS OF WATER EXCHANGE AND BLUE CRAB CONTROL ON SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IMPOUNDMENTS ...**2.0275**

BIOLOGICAL STUDIES OF MALACOPHAGOUS DIPTERA ...**2.0282**

EFFECTS OF A SNAPPING TURTLE POPULATION ON THE WATERFOWL PRODUCTIVITY OF A MARSH ...**2.0292**

OYSTER DRIL (OCINEBRA JAPONICA) CONTROL ...**2.0293**

PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...**3.0047**

AQUICULTURE, OYSTER HATCHERIES - RESEARCH ...**3.0118**

AQUATIC & SEMI-AQUATIC DIPTERA STUDIES ...**4.0073**

Symbiosis

MARINE FISHERIES - SYMBIOSIS AND PARASITISM - RESEARCH ...**3.0055**

Life History Studies -animal

RESEARCH STUDY ON THE EFFECTS OF POLLUTION ON SUB-TROPICAL FISH AND CRUSTACEANS ...**1.0237**

THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...**1.0253**

ACCUMULATION OF PESTICIDES IN MENHADEN ...**1.0299**

CLASSIFICATION, BIONOMICS, ECOLOGY CONTROL OF FOREST INSECTS (OTHER THAN SCOLYTIDAE) IN CAL. ...**1.0321**

BIOLOGY OF PEST MOSQUITOES, AND CONTROL THROUGH COMMUNITY ACTION ...**2.0004**

CONTROL OF COMMON HOUSEFLY ...**2.0005**

SUPPRESSION AND ECOLOGY OF MOSQUITOES ...**2.0018**

IDENTIFICATION AND CHARACTERIZATION OF MOSQUITO PATHOGENS ...**2.0020**

BIOLOGICAL CONTROL OF INSECTS AFFECTING MAN ...**2.0027**

INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...**2.0030**

FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...**2.0053**

BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS ...**2.0054**

STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS ...**2.0067**

INSECTS AFFECTING MAN ...**2.0068**

DISTRIBUTION AND ECOLOGY OF PENNSYLVANIA SALAMANDERS ...**2.0080**

INSECTS AFFECTING MAN AND ANIMALS ...**2.0081**

ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0117**

NATURAL ENEMIES OF EURASIAN WATERMILFOIL IN PAKISTAN ...**2.0173**

NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...**2.0188**

SQUAWFISH CONTROL IN CASCADE RESERVOIR ...**2.0195**

SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...**2.0206**

SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...**2.0207**

BIOLOGY OF THE LARVAL SEA LAMPREY ...**2.0210**

PRE-LAMPREY CONTROL INVENTORY OF FISH STOCKS ...**2.0222**

POPULATION DYNAMICS - LAKE TROUT ...**2.0235**

BIOLOGY AND CONTROL OF SNAILS ...**2.0268**

SEA NETTLE STUDIES IN CHESAPEAKE BAY, LIFE HISTORY AND ECOLOGY ...**2.0273**

BIOLOGY AND CONTROL OF TERRESTRIAL MOLLUSCS ...**2.0281**

BIOLOGICAL STUDIES OF MALACOPHAGOUS DIPTERA ...**2.0282**

BIOLOGY AND CONTROL OF TERRESTIAL MOLLUSKS ...**2.0289**

THE CONTROL OF SLUGS ...**2.0294**

COOPERATIVE FISH DISEASE PROJECT ...**3.0012**

SHELLFISH MORTALITY - CHESAPEAKE BAY ...**3.0033**

PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...**3.0047**

INFECTIOUS DISEASES OF SALMONID FISHES ...**3.0049**

ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...**3.0052**

USE OF TISSUE SECTIONING TECHNIQUES TO ATTEMPT TO FOLLOW THE LIFE HISTORY OF WHIRLING DISEASE PARASITES FROM THE FIRST DAY OF INFECTION ...**3.0065**

PATHOLOGY - EPIZOOTIOLOGY ...**3.0113**

CULTIVATION OF INSECT PHASE OF AVIAN PLASMODIA ...4.0036

BIOLOGICAL STUDIES OF CULICOIDES AND THEIR CONTROL IN THE CANAL ZONE ...4.0043

ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044

DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053

OCCURRENCE AND BIONOMICS OF BLOODSUCKING MIDGES (DIPTERA: CERATOPOGONIDAE) IN IOWA ...4.0056

BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...4.0058

BIONOMICS OF MARYLAND MOSQUITOES ...4.0063

ASSESSMENT OF THE IMPORTANCE OF FILARIASIS IN THAILAND ...4.0072

AQUATIC & SEMI-AQUATIC DIPTERA STUDIES ...4.0073

A STUDY OF THE INTERACTION OF THREE SPECIES OF BULLHEAD AND ASSOCIATED GAME FISH SPECIES IN A SINGLE LAKE ...4.0079

FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES ...4.0080

REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES ...4.0083

NORTHERN PIKE LIFE HISTORY STUDY ...4.0084

WALLEYE LIFE HISTORY STUDY ...4.0085

SURVEYS FOR PANFISH CONTROL STUDIES ...4.0086

Population Dynamics

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039

AN EVALUATION OF THE INSECTICIDE 'SEVIN' AS A WATERSHED POLLUTANT ...1.0067

ESTUARINE ECOSYSTEMS ...1.0128

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133

MAYFLY DISTRIBUTION AS A WATER QUALITY INDEX ...1.0169

FISHERIES UNIT ...1.0203

EFFECTS OF WATER POLLUTION ON ZOOPLANKTON ...1.0207

PHYSICAL AND CHEMICAL FACTORS AFFECTING FISH ...1.0246

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260

THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...1.0297

THE EFFECT OF DIELDRIN ON SURVIVAL AND DEVELOPMENT OF FISH EGGS ...1.0300

EFFECT OF PESTICIDE RESIDUES ON GAME FISH POPULATIONS ...1.0310

DETERMINATION OF DIGESTION RATES FOR TROUT ...1.0346

EVALUATION OF GIZZARD SHAD AS A FORAGE FISH ...1.0356

TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...2.0007

BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES ...2.0014

BIOLOGY OF MICROORGANISMS OF MOSQUITOES ...2.0022

CONTROL OF CULEX NIGRIPALPUS BY STERILITY METHODS ...2.0032

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS ...2.0033

BIOLOGY AND ECOLOGY OF SALT-MARSH MOSQUITOES OF LOUISIANA ...2.0042

BIOLOGICAL AND BIOCHEMICAL FACTORS INFLUENCING THE DEVELOPMENT OF LARVAL MOSQUITO POPULATIONS ...2.0052

SURVEY OF INSECT PROBLEMS IN MONTANA ...2.0059

MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...2.0060

EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...2.0075

EMERGENCY INSECT CONTROL ...2.0076

MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085

FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...2.0142

EXPERIMENTAL USE OF PESTICIDES FOR FISHERIES MANAGEMENT PURPOSES ...2.0189

SMALL IMPOUNDMENT STOCKING ...2.0190

HAUL SEINE STUDY ...2.0192

STRIPED BASS STUDIES ...2.0193

JO-MARY POND RECLAMATION ...2.0201

ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202

SEA LAMPREY CONTROL - LAKE MICHIGAN CHEMICAL CONTROL ...2.0203

SEA LAMPREY CONTROL - LAKE HURON CHEMICAL CONTROL ...2.0204

SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...2.0206

SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...2.0207

SEA LAMPREY CONTROL - ASSESSMENT METHODS ...2.0208

BIOLOGY OF THE LARVAL SEA LAMPREY ...2.0210

EXPERIMENTAL ESTABLISHMENT OF MONOSPECIFIC WALLEYE POPULATIONS AS A MANAGEMENT MEASURE FOR SMALL WARMWATER LAKES IN NORTHERN MINNESOTA ...2.0214

THE INTERACTION OF THE WALLEYE AND WHITE SUCKER IN THE FISH POPULATION OF SOFT WATER LAKE IN NORTHEASTERN MINNESOTA ...2.0215

EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP SOFTWATER LAKES ...2.0216

PLANNING FOR CREATION OF SALMONID FISHERIES IN LAKE ONTARIO ...2.0221

MERIDIAN STATE PARK LAKE CRAPPIE REMOVAL EXPERIMENT ...2.0231

POPULATION DYNAMICS - LAKE TROUT ...2.0235

THE CONTROL OF SLUGS ...2.0294

EPIZOOTIOLOGY OF PARASITIC DISEASES IN FISH POPULATIONS UNDER INTENSIVE MANAGEMENT ...3.0001

RESEARCH VESSEL OPERATIONS ...3.0048

PATHOLOGY - EPIZOOTIOLOGY ...3.0113

DEVELOPMENT OF CULTURE METHODS FOR MOSQUITOES ...4.0035

ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...4.0039

POPULATION DYNAMICS OF MOSQUITOES IN FLORIDA ...4.0048

ARTHROPOD-BORNE VIRUS (ARBOVIRUS) ACTIVITY IN MAJOR MOSQUITO VECTORS IN IOWA ...4.0057

BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS ...4.0061

MOSQUITOES AS VECTORS OF LIVESTOCK DISEASES ...4.0065

RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070

RENOVATION OF TROUT STREAMS ...4.0076

LIFE HISTORY OF ST. JOE RIVER CUTTHROAT TROUT ...4.0077

POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078

GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081

SURVEYS FOR PANFISH CONTROL STUDIES ...4.0086

Productivity - Food Chain

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133

THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...1.0297

SELECTED PESTICIDES VS. WILDLIFE IN AQUATIC ENVIRONMENTS ...1.0325

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...1.0328

FARM FISH POND MANAGEMENT ...1.0340

INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0351**

POND ECOLOGY AND PRODUCTION AS AFFECTED BY SIMAZINE ...**1.0353**

STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970 ...**1.0354**

THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...**1.0359**

STUDY ON THE EFFECTS OF FISH TOXICANTS ANTIMYCIN A AND ROTENONE ON POND COMMUNITIES ...**1.0366**

EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE I ...**2.0073**

IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...**3.0018**

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...**3.0029**

LAKE SUPERIOR PERIPHYTON IN RELATION TO WATER QUALITY ...**4.0017**

INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...**4.0059**

POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...**4.0078**

Ecology - Plant

Applied Ecology

BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...**2.0121**

Aquatic Plant Groups

Amphibious Plants

PESTICIDE RESIDUES ON ARIZONA CROPS ...**1.0007**

ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...**2.0001**

EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE I ...**2.0073**

EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...**2.0075**

AQUATIC WEED CONTROL RESEARCH ...**2.0100**

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...**2.0104**

AQUATIC PEST CONTROL ...**2.0112**

EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...**2.0116**

WEED CONTROL IN CITRICULTURE ...**2.0123**

THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...**2.0130**

CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...**2.0154**

CONTROL OF EURASIAN MILFOIL ...**2.0156**

WATERLEVEL MANAGEMENT ON IMPOUNDMENTS OF LOW QUALITY SOILS ...**2.0163**

WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...**2.0176**

CHANGES IN WATER ENVIRONMENT RESULTING FROM AQUATIC PLANT CONTROL ...**2.0183**

NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...**2.0188**

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...**3.0029**

BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...**4.0012**

THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0020**

EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...**4.0023**

NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE ...**4.0025**

THE CHANGING DISTRIBUTION OF THE GENUS POTAMOGETON (PONDWEEDS) IN OHIO ...**4.0026**

EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...**4.0029**

Aquatic Plants -nonspecific

GREEN BAY RESEARCH PROGRAM ...**1.0112**

ESTUARINE ECOSYSTEMS ...**1.0128**

TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE ...**1.0201**

THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...**1.0297**

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...**1.0319**

FATE OF AQUATIC HERBICIDES IN THE AQUATIC ENVIRONMENT ...**1.0329**

AQUATIC PLANT CONTROL BY HERBIVOROUS AMUR FISH ...**2.0092**

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...**2.0096**

BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...**2.0121**

BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...**2.0122**

SURVEY OF POND WEEDS AND PLANT SUCCESSION ...**2.0127**

AQUATIC PLANT CONTROL ...**2.0128**

AQUATIC WEED SUPPRESSION AND CONTROL IN LARGE CANALS ...**2.0132**

FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS ...**2.0141**

THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...**2.0150**

ALLEVIATION OF LAKE POLLUTION BY UTILIZATION OF AQUATIC PLANTS FOR NUTRITIONAL, MEDICINAL OR INDUSTRIAL PURPOSES ...**2.0152**

BIOLOGY AND CONTROL OF AQUATIC WEEDS ...**2.0162**

THE CRAYFISH (ORCONECTES CAUSEYI) AS A BIOLOGICAL CONTROL OF AQUATIC VEGETATION ...**2.0175**

ENVIRONMENTAL STUDY ...**3.0030**

LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...**4.0010**

RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...**4.0019**

INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...**4.0027**

AQUATIC PLANTS OF POLLUTED WATERS IN SOUTHWESTERN UNITED STATES ...**4.0028**

Floating Plants

BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0115**

EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...**2.0116**

SOUTHEASTERN BIOLOGICAL CONTROL OF WEEDS INVESTIGATIONS ...**2.0120**

FACTORS CONTROLLING THE GROWTH OF THE AQUATIC WEED SALVINIA ...**2.0166**

TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ...**4.0030**

Lower Plants

DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...**2.0094**

AQUATIC PEST CONTROL ...**2.0112**

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...**2.0174**

STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...**4.0022**

Riparian Plants

QUALITY OF IRRIGATION RETURN FLOW ...**1.0102**

COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...**1.0125**

PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...**2.0105**

HERBICIDE RESIDUES ...**2.0109**

WEED CONTROL IN CITRICULTURE ...**2.0123**

THE USE OF FLAME FOR CONTROLLING WEEDS AND BRUSH ...**2.0136**

CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...**2.0160**

RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...**2.0161**

CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...**2.0178**

CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...**2.0187**

Submerged Plants

COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...**1.0125**

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...**1.0228**

AQUATIC WEED CONTROL RESEARCH ...**2.0100**

CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...**2.0101**

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...**2.0104**

PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...**2.0105**

AROMATIC SOLVENT AQUATIC HERBICIDES AND EMULSIFYING AGENT TESTING ...**2.0107**

GROWTH SUPPRESSION AND REDUCTION IN REGROWTH POTENTIAL OF AQUATIC WEEDS ...**2.0110**

BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0115**

EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...**2.0116**

ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0117**

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0118**

WEED CONTROL IN CITRICULTURE ...**2.0123**

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0129**

THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...**2.0130**

DETERMINATION OF THE EFFECTS OF A FERTILIZER-INDUCED PLANKTON TURBIDITY, SUPPLEMENTED BY HERBICIDES, ON SUBMERGED AQUATIC PLANTS ...**2.0137**

EXPANDED AQUATIC PLANT CONTROL PROJECT ...**2.0146**

CONTROL OF CANADA THISTLE AND WATER WEEDS ...**2.0158**

FIELD INVESTIGATION OF THE SUBMERSED AQUATIC ENVIRONMENT ...**4.0003**

ANATOMICAL, PHYSIOLOGICAL AND ECOLOGICAL STUDIES ON MYRIOPHYLLUM SPICATIU ...**4.0013**

THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0014**

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0024**

THE CHANGING DISTRIBUTION OF THE GENUS POTAMOGETON (PONDWEEDS) IN OHIO ...**4.0026**

Balance of Nature

EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...**2.0075**

EUTROPHICATION - EFFECT OF WEED HARVESTING ...**2.0169**

Dispersion

PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN ...**1.0213**

POTENTIAL OF COELOMOMYCES FOR CONTROLLING MOSQUITOES ...**2.0071**

DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...**2.0094**

CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...**2.0154**

CONTROL AND UTILIZATION OF AQUATIC PLANTS ...**2.0157**

ENVIRONMENTAL STUDY ...**3.0030**

BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...**4.0012**

THE CHANGING DISTRIBUTION OF THE GENUS POTAMOGETON (PONDWEEDS) IN OHIO ...**4.0026**

AQUATIC PLANTS OF POLLUTED WATERS IN SOUTHWESTERN UNITED STATES ...**4.0028**

Ecotypes

CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...**2.0160**

Epiphytic Relationships

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...**4.0018**

Eutrophication

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...**1.0161**

A STUDY OF INHIBITORY COMPOUNDS PRODUCED BY FRESH-WATER ALGAE ...**2.0138**

ALGAE CONTROL BY ARTIFICIAL MIXING IN LAKE COCHITUATE ...**2.0149**

EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...**2.0165**

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...**2.0168**

EUTROPHICATION - EFFECT OF WEED HARVESTING ...**2.0169**

EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...**2.0170**

EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...**2.0171**

EUTROPHICATION - PILOT OPERATIONS ...**2.0172**

NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...**2.0180**

LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...**2.0184**

EUTROPHICATION OF IOWA LAKES AND STREAMS ...**4.0008**

AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...**4.0011**

PHYTOPLANKTON NUTRITION AND PHOTOSYNTHESIS IN EUTROPHIC LAKES ...**4.0016**

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...**4.0018**

RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...**4.0019**

EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...**4.0023**

INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...**4.0027**

EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...**4.0029**

Floras

VIBRIO PARAHAEMOLYTICUS IN CHESAPEAKE BAY - ISOLATION, INCIDENCE AND PATHOGENICITY ...**3.0026**

Food Chains

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...**3.0029**

Freshwater Ecology

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...**1.0161**

THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM ...**1.0350**

DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...**2.0094**

THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...**2.0150**

RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY ...**4.0002**

STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...**4.0022**

NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE ...**4.0025**

THE CHANGING DISTRIBUTION OF THE GENUS POTAMOGETON (PONDWEEDS) IN OHIO ...4.0026

EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029

Habitat Studies

RESPROUTING OF CHAPARRAL ...1.0017

SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...2.0095

TESTING OF NEW HERBICIDES ...2.0125

SURVEY OF POND WEEDS AND PLANT SUCCESSION ...2.0127

CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...2.0185

NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...4.0018

THE CHANGING DISTRIBUTION OF THE GENUS POTAMOGETON (PONDWEEDS) IN OHIO ...4.0026

Phenology

AQUATIC WEED CONTROL RESEARCH ...2.0100

CONTROL OF CANADA THISTLE AND WATER WEEDS ...2.0158

Physiological Ecology

STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...4.0022

Plant Succession

EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...4.0023

Dominant Organisms

RESPROUTING OF CHAPARRAL ...1.0017

Lake Stages

SURVEY OF POND WEEDS AND PLANT SUCCESSION ...2.0127

EUTROPHICATION - EFFECT OF WEED HARVESTING ...2.0169

NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180

LIMNOLOGICAL, ICHTHYOLOGICAL, AND PARASITOLOGICAL INVESTIGATIONS ON ARKANSAS RESERVOIRS IN RELATION TO WATER QUALITY ...3.0019

AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...4.0011

Population Dynamics -ns

ESTUARINE ECOSYSTEMS ...1.0128

EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...4.0023

Productivity

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029

Primary Productivity

GREEN BAY RESEARCH PROGRAM ...1.0112

THE FACTOR CONTROLLING THE DYNAMICS OF NON-IONIC SYNTHETIC ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS ...1.0148

FARM FISH POND MANAGEMENT ...1.0340

THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM ...1.0350

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168

EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...2.0171

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174

PHYTOPLANKTON NUTRITION AND PHOTOSYNTHESIS IN EUTROPHIC LAKES ...4.0016

NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE ...4.0025

Standing Crops

BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342

Economics

ECONOMIC EFFECTS OF PESTICIDES AND OTHER WASTES ON NATURAL RESOURCE QUALITY ...1.0026

WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...1.0162

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183

DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...1.0184

WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...2.0176

CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187

Agricultural Economics

PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES ...1.0062

ILLINOIS LAWS AFFECTING AGRICULTURE ...1.0332

Economic Efficiency

ECONOMIC EFFECTS OF PESTICIDES AND OTHER WASTES ON NATURAL RESOURCE QUALITY ...1.0026

EUTROPHICATION - PILOT OPERATIONS ...2.0172

IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...2.0181

Economic Impact

ECONOMIC EFFECTS OF PESTICIDES AND OTHER WASTES ON NATURAL RESOURCE QUALITY ...1.0026

GREEN BAY RESEARCH PROGRAM ...1.0112

Income Analysis

ILLINOIS LAWS AFFECTING AGRICULTURE ...1.0332

Losses or Benefits From . . .

Insects

BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...2.0040

MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...2.0062

THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078

EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082

Losses Due to Pollution

ECONOMIC EFFECTS OF PESTICIDES AND OTHER WASTES ON NATURAL RESOURCE QUALITY ...1.0026

Microeconomics

Costs

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183

INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106

Production & Processing

GREEN BAY RESEARCH PROGRAM ...1.0112

Natural Resources Economics

GREEN BAY RESEARCH PROGRAM ...1.0112

Optimization

ECONOMIC EFFECTS OF PESTICIDES AND OTHER WASTES ON NATURAL RESOURCE QUALITY ...1.0026

Regional

GREEN BAY RESEARCH PROGRAM ...1.0112

Ectoprocta

AQUATIC WEED CONTROL RESEARCH ...2.0100
WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104

Edta

THE EFFECTS OF DIFFERENTLY EXTRACTED ENDOTOXINS FROM ESCHERICHIA COLI ON RAINBOW TROUT (SALMO GAIRDNERI) ...3.0071

Electrical Water Properties

PROPERTIES OF TILE DRAINAGE WATER ...1.0045
UPPER ST. JOHNS RIVER BASIN WATER QUALITY, FLORIDA ...1.0134
ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211

Electrochemistry

STUDY OF ELECTROHYDRAULIC WATER TREATMENT ...1.0121
ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211

Electrophoresis

ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211

Elevational Levels, Altitude

DDT IN SNOW FALLEN AT HIGH ALTITUDE SINCE 1950 ...1.0214

Encephalitis

ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ..4.0046
JAPANESE ENCEPHALITIS ON GUAM ...4.0062
CALIFORNIA ENCEPHALITIS VIRUS IN WISCONSIN ...4.0075

Endogenous Biological Extracts

Endogenous Cpds -animal

SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...2.0028
INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...2.0030
BIOLOGY AND BIOLOGICAL CONTROL OF SCHISTOSOMIASIS ...2.0277
(U) REPELLENCY AND ATTRACTIVENESS OF MAN TO MOSQUITO BITES ...4.0040
ATTRACTIVENESS AND REPELLENCY OF MAN TO MOSQUITO BITES ...4.0041
DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...4.0051

Endogenous Cpds -plants

TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...2.0007
MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...2.0019
IDENTIFICATION AND CHARACTERIZATION OF MOSQUITO PATHOGENS ...2.0020
MODE OF ACTION OF A NEW FUNGAL PATHOGEN OF MOSQUITOES ...2.0070
ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089
A STUDY OF INHIBITORY COMPOUNDS PRODUCED BY FRESH-WATER ALGAE ...2.0138
CONTROL AND UTILIZATION OF AQUATIC PLANTS ...2.0157
EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...2.0165
LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...2.0184
ROTENOIDS FROM TEPHROSIA VOGELII ...2.0198
CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS ...2.0265
INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...2.0280

Energy Budgets

EUTROPHICATION - EFFECT OF WEED HARVESTING ...2.0169

Engineering Structures-general

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133
INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106
TRIBUTARY SURVEY OF LAKES ONTARIO AND ERIE ...2.0220
EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...3.0083
EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029

Entomology, Applied

Biological Control of Insects

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...1.0249
CLASSIFICATION, BIONOMICS, ECOLOGY CONTROL OF FOREST INSECTS (OTHER THAN SCOLYTIDAE) IN CAL. ...1.0321
ECOLOGICAL STUDIES OF WILDLIFE MANAGEMENT PRACTICES ...1.0327
ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001
BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...2.0006
TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...2.0007
INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...2.0010
BIOLOGY AND CONTROL OF MOSQUITOES IN IRRIGATED AND WATER MANAGEMENT AREAS ...2.0011
SUPPLYING GENETIC MARKER AND INCOMPATIBLE STRAINS OF CULEX PIPIENS ...2.0012
CYTOPLASMIC INCOMPATIBILITY FOR FILARIASIS CONTROL ...2.0013
BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES ...2.0014
MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...2.0019
IDENTIFICATION AND CHARACTERIZATION OF MOSQUITO PATHOGENS ...2.0020
BIOLOGY OF MICROORGANISMS OF MOSQUITOES ...2.0022
DEVELOPMENT AND BEHAVIOR OF BITING DIPTERA ...2.0023
BIOLOGICAL CONTROL OF INSECTS AFFECTING MAN ...2.0027
INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...2.0029
CULTIVATION OF COELOMOMYCES, A FUNGAL PARASITE OF MOSQUITOES ...2.0031
CONTROL OF CULEX NIGRIPALPUS BY STERILITY METHODS ...2.0032
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS ...2.0033
GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...2.0034
VIRAL PATHOGENS ...2.0035
RADIATION CYTOGENETICS OF THE YELLOW-FEVER MOSQUITO, AEDES AEGYPTI ...2.0036

POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038
CYTOPLASMIC INHERITANCE AND CONTROL OF CULEX PIPIENS ...2.0041
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043
EFFECT OF PREDATORS AND PARASITES ON MOSQUITO BREEDING IN LOUISIANA ...2.0045
CONTROL OF BLACK FLIES AND MOSQUITOES IN MAINE ...2.0046
INTERSPECIFIC COMPETITION AMONG MOSQUITOES ...2.0047
GENETIC STUDIES ON THE CONTROL OF ARBOVIRUS VECTORS ...2.0048
INSECT CHEMOSTERILANTS ...2.0049
FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...2.0053
INSECT SURVEY OF MONTANA ...2.0058
MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...2.0060
STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS ...2.0067
INSECTS AFFECTING MAN ...2.0068
MODE OF ACTION OF A NEW FUNGAL PATHOGEN OF MOSQUITOES ...2.0070
POTENTIAL OF COELOMOMYCES FOR CONTROLLING MOSQUITOES ...2.0071
STUDIES ON SOME FUNGAL PARASITES OF MOSQUITOES ...2.0072
EMERGENCY INSECT CONTROL ...2.0076
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...2.0079
DISTRIBUTION AND ECOLOGY OF PENNSYLVANIA SALAMANDERS ...2.0080
INSECTS AFFECTING MAN AND ANIMALS ...2.0081
MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085
BIOLOGICAL FACTORS IN THE MANAGEMENT OF LAKE FLIES ...2.0088
ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089
THE NUTRITION AND BEHAVIOR OF MOSQUITOES ...4.0033
BIOLOGICAL STUDIES OF CULICOIDES AND THEIR CONTROL IN THE CANAL ZONE ...4.0043
BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...4.0045
DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053
GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055
AQUATIC & SEMI-AQUATIC DIPTERA STUDIES ...4.0073

Cereal Crops

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0038
CONTROL OF PESTICIDES IN SOIL AND WATER ...1.0054
EFFECTS OF INSECTICIDES ON ACTIVITY OF SOIL INHABITING INSECTS ...1.0059
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0334
FACTORS AFFECTING ROLE OF MICROORGANISMS IN BIOLOGICAL CONTROL OF INSECT PESTS ...2.0037
EMERGENCY INSECT CONTROL ...2.0076
DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053

Chemical Control of Insects

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0038
PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS ...1.0063
PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...1.0075
FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL ...1.0077
EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...1.0249
PESTICIDE CONTAMINATION OF ENVIRONMENT ...1.0250
PESTICIDES AND WILDLIFE ...1.0324
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0334
EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS ...1.0341
ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001
EFFECT OF MOSQUITO CONTROL CHEMICALS ON AQUATIC FAUNA ...2.0003
CONTROL OF COMMON HOUSEFLY ...2.0005
BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...2.0006
BIOLOGY AND CONTROL OF PASTURE MOSQUITOES ...2.0008
AERIAL DISPERSAL METHODS FOR CONCENTRATED INSECTICIDES ...2.0009
INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...2.0010
EVALUATION OF NEW INSECTICIDES ...2.0015
NEW INSECTICIDES & TECHNIQUES FOR PEST CONTROL ...2.0016
STUDIES ON INSECTICIDE RESISTANCE IN MOSQUITOES ...2.0017
INVESTIGATIONS OF PHEROMONES AS CHEMOSTERILANTS FOR INSECTS WITH SPECIAL REFERENCE TO SYNTHETIC QUEN SUBSTANCE AND ITS ANALOGUES ...2.0021
TESTING ADULT ATTRACTION DEVICES AND CHEMOSTERILANTS FOR TABANID FLY CONTROL ...2.0024
INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025
INVESTIGATIONS OF THE ACTION OF CHEMOSTERILANTS ON HOUSEFLIES AND OTHER MEDICALLY IMPORTANT ARTHROPODS ...2.0026
SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...2.0028
RELATION OF APPLICATION METHODS, CONCENTRATION, AND VOLUME OF INSECTICIDE TO CATTLE INSECT CONTROL ...2.0039
BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...2.0040
CONTROL OF BLACK FLIES AND MOSQUITOES IN MAINE ...2.0046
INSECT CHEMOSTERILANTS ...2.0049
BIOLOGICAL EVALUATION OF INSECT CONTROL AGENTS ...2.0050
MALARIA ERADICATION RESEARCH ...2.0051
SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...2.0055
ABUNDANCE, DISTRIBUTION AND CONTROL OF MISCELLANEOUS INSECTS, AFFECTING LIVESTOCK ...2.0056
BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057
SURVEY OF INSECT PROBLEMS IN MONTANA ...2.0059
MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...2.0060
COORDINATION OF MOSQUITO CONTROL IN NEW JERSEY ...2.0061
MOSQUITO CONTROL - TIDAL MARSHES ...2.0063
MOSQUITO CONTROL IN UPLAND SWAMPS ...2.0065
CONTROLLING MOSQUITOES ON HAYING MEADOWS ...2.0066
STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS ...2.0067
INSECTS AFFECTING MAN ...2.0068
LEGAL REPRESENTATION OF CITIZEN'S INTERESTS IN ENVIRONMENTAL PROTECTION ...2.0069
EMERGENCY INSECT CONTROL ...2.0076
NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077
THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...2.0079
INSECTS AFFECTING MAN AND ANIMALS ...2.0081
EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082
MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085
SELECTIVE TOXICITY BY OPTICALLY ACTIVE PHOSPHONOTHIONATE PESTICIDES ...2.0086
INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087
ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089
EFFECT OF BITING FLIES ON WEIGHT GAINS IN CATTLE ...2.0090
ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288
ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE ...4.0031
BIOLOGICAL STUDIES OF CULICOIDES AND THEIR CONTROL IN THE CANAL ZONE ...4.0043
BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...4.0045
BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN ...4.0047
BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...4.0058
RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070

Coniferous Forests

CLASSIFICATION, BIONOMICS, ECOLOGY CONTROL OF FOREST INSECTS (OTHER THAN SCOLYTIDAE) IN CAL. ...1.0321

Cultural Control of Insects

BIOLOGY AND CONTROL OF PASTURE MOSQUITOES ...2.0008
BIOLOGY AND WATER MANAGEMENT STUDIES FOR CONTROL OF LOUISIANA MOSQUITOES (RICE FIELDS) ...2.0044
WATER MANAGEMENT IN MOSQUITO IMPOUNDMENTS ...2.0064
MOSQUITO CONTROL IN UPLAND SWAMPS ...2.0065
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE 1 ...2.0073

Ectoparasitic Insects

MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...1.0266
CONTROL OF COMMON HOUSEFLY ...2.0005
INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...2.0010
BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...2.0040
ABUNDANCE, DISTRIBUTION AND CONTROL OF MISCELLANEOUS INSECTS, AFFECTING LIVESTOCK ...2.0056
NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077
THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078
INSECTS AFFECTING MAN AND ANIMALS ...2.0081
EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082
ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...2.0083
INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087
ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE ...4.0031
BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...4.0045
A STUDY IN INSECT TRANSMISSION OF ANAPLASMOSIS ...4.0064
MOSQUITOES AS VECTORS OF LIVESTOCK DISEASES ...4.0065

Endoparasitic Insects

ABUNDANCE, DISTRIBUTION AND CONTROL OF MISCELLANEOUS INSECTS, AFFECTING LIVESTOCK ...2.0056
THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078
TRANSMISSION OF ANAPLASMOSIS ...4.0032
BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...4.0045

Factors Affecting Insect Pop.

Disease, Predators

FACTORS AFFECTING ROLE OF MICROORGANISMS IN BIOLOGICAL CONTROL OF INSECT PESTS ...2.0037
STUDIES ON SOME FUNGAL PARASITES OF MOSQUITOES ...2.0072

Edaphic or Soil Conditions

OCCURRENCE AND BIONOMICS OF BLOODSUCKING MIDGES (DIPTERA: CERATOPOGONIDAE) IN IOWA ...4.0056

Food

INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...2.0010
INSECTS AFFECTING MAN ...2.0068
INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087
FEEDING HABITS OF MOSQUITO LARVAE ...4.0034
BIONOMICS OF MARYLAND MOSQUITOES ...4.0063
A STUDY IN INSECT TRANSMISSION OF ANAPLASMOSIS ...4.0064
ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...4.0069
PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA ...4.0074

Fiber Crops

EVALUATION OF NEW INSECTICIDES ...2.0015

Forage and Range Grasses

BIOLOGY AND CONTROL OF PASTURE MOSQUITOES ...2.0008
DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053

Host Preference, Host-insect

TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...2.0007
INSECTS AFFECTING MAN AND ANIMALS ...2.0081
INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087
SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...2.0095
BIOLOGICAL CONTROL OF WEEDS ...2.0099
BIOLOGICAL CONTROL OF WEEDS ...2.0102
SOUTHEASTERN BIOLOGICAL CONTROL OF WEEDS INVESTIGATIONS ...2.0120
NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135
NATURAL ENEMIES OF EURASIAN WATERMILFOIL IN PAKISTAN ...2.0173
NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188

Household Insects

EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...2.0002
INSECTS AFFECTING MAN ...2.0068
DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...4.0051

Insect Control -nonspecific

EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...2.0002
BIOLOGY OF PEST MOSQUITOES, AND CONTROL THROUGH COMMUNITY ACTION ...2.0004

INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...2.0030
SURVEY OF INSECT PROBLEMS IN MONTANA ...2.0059
THE CONTROL OF MOSQUITOES OF MILITARY IMPORTANCE AND THE PREVENTION OF MOSQUITO-BORNE DISEASES ...2.0074
ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...2.0083
ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE ...4.0031
BIONOMICS OF MARYLAND MOSQUITOES ...4.0063
MOSQUITOES AS VECTORS OF LIVESTOCK DISEASES ...4.0065
CALIFORNIA ENCEPHALITIS VIRUS IN WISCONSIN ...4.0075

Insectal Biocontrol o.

Insectal Biocontrol -other
BIOLOGICAL STUDIES OF MALACOPHAGOUS DIPTERA ...2.0282
EUROPEAN SCIOMYZIDAE ...2.0283

Insects
BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057
STUDY THE BIOLOGY OF A GROUP OF SNAIL-KILLING FLIES ...2.0287
AQUATIC & SEMI-AQUATIC DIPTERA STUDIES ...4.0073

Weeds
SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...2.0095
BIOLOGICAL CONTROL OF WEEDS ...2.0099
BIOLOGICAL CONTROL OF WEEDS ...2.0102
SOUTHEASTERN BIOLOGICAL CONTROL OF WEEDS INVESTIGATIONS ...2.0120
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0129
NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135
INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...2.0144
INSECTS ASSOCIATED WITH AQUATIC WEED PESTS OF FOREIGN ORIGIN ...2.0145
NATURAL ENEMIES OF EURASIAN WATERMILFOIL IN PAKISTAN ...2.0173
METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186
NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188
BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...2.0269

Legume Crops
PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS ...1.0063

Myiasis
TRANSMISSION OF ANAPLASMOSIS ...4.0032

Nuisance Species
BIOLOGY OF PEST MOSQUITOES, AND CONTROL THROUGH COMMUNITY ACTION ...2.0004
BIOLOGY AND CONTROL OF PASTURE MOSQUITOES ...2.0008
INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...2.0010
BIOLOGY AND CONTROL OF MOSQUITOES IN IRRIGATED AND WATER MANAGEMENT AREAS ...2.0011
BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES ...2.0014
SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...2.0028
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS ...2.0033
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043
BIOLOGICAL AND BIOCHEMICAL FACTORS INFLUENCING THE DEVELOPMENT OF LARVAL MOSQUITO POPULATIONS ...2.0052
STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS ...2.0067
INSECTS AFFECTING MAN ...2.0068
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE I ...2.0073
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...2.0075
INSECTS AFFECTING MAN AND ANIMALS ...2.0081
MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085
BIOLOGICAL FACTORS IN THE MANAGEMENT OF LAKE FLIES ...2.0088
DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053

Oilseed Crops
EMERGENCY INSECT CONTROL ...2.0076

Outbreaks of Insects
CLASSIFICATION, BIONOMICS, ECOLOGY CONTROL OF FOREST INSECTS (OTHER THAN SCOLYTIDAE) IN CAL. ...1.0321
EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...2.0002
DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053

Physical Control of Insects
DEVELOPMENT AND BEHAVIOR OF BITING DIPTERA ...2.0023
INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025
BIOLOGICAL AND BIOCHEMICAL FACTORS INFLUENCING THE DEVELOPMENT OF LARVAL MOSQUITO POPULATIONS ...2.0052
MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...2.0060
MOSQUITO CONTROL - TIDAL MARSHES ...2.0063
CONTROLLING MOSQUITOES ON HAYING MEADOWS ...2.0066
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE I ...2.0073
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...2.0075
EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082
BIOLOGICAL STUDIES OF CULICOIDES AND THEIR CONTROL IN THE CANAL ZONE ...4.0043
OCCURRENCE AND BIONOMICS OF BLOODSUCKING MIDGES (DIPTERA: CERATOPOGONIDAE) IN IOWA ...4.0056

Rearing of Insects
EFFECTS OF INSECTICIDES ON ACTIVITY OF SOIL INHABITING INSECTS ...1.0059
SUPPLYING GENETIC MARKER AND INCOMPATIBLE STRAINS OF CULEX PIPIENS ...2.0012
SUPPRESSION AND ECOLOGY OF MOSQUITOES ...2.0018
MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...2.0019
BIOLOGY OF MICROORGANISMS OF MOSQUITOES ...2.0022
BIOLOGICAL CONTROL OF INSECTS AFFECTING MAN ...2.0027
INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...2.0029
CONTROL OF CULEX NIGRIPALPUS BY STERILITY METHODS ...2.0032
BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...2.0040
CONTROL OF BLACK FLIES AND MOSQUITOES IN MAINE ...2.0046
INTERSPECIFIC COMPETITION AMONG MOSQUITOES ...2.0047

- BIOLOGICAL AND BIOCHEMICAL FACTORS INFLUENCING THE DEVELOPMENT OF LARVAL MOSQUITO POPULATIONS ...2.0052
- BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057
- STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS ...2.0067
- STUDIES ON SOME FUNGAL PARASITES OF MOSQUITOES ...2.0072
- SUSCEPTIBILITY OR RESISTANCE OF MEDICALLY IMPORTANT INSECTS TO INSECTICIDES ON SELECTED AIR FORCE BASES ...2.0084
- MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085
- NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188
- EUROPEAN SCIOMYZIDAE ...2.0283
- STUDY THE BIOLOGY OF A GROUP OF SNAIL-KILLING FLIES ...2.0287
- THE NUTRITION AND BEHAVIOR OF MOSQUITOES ...4.0033
- FEEDING HABITS OF MOSQUITO LARVAE ...4.0034
- DEVELOPMENT OF CULTURE METHODS FOR MOSQUITOES ...4.0035
- CULTIVATION OF INSECT PHASE OF AVIAN PLASMODIA ...4.0036
- MOSQUITOES OF MIDDLE AMERICA ...4.0038
- BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...4.0045
- ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046
- BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN ...4.0047
- MOSQUITOES OF THE NEW GUINEA AREA ...4.0050
- THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...4.0052
- BIONOMICS OF SELECTED NORTH AMERICAN CULICINE MOSQUITOES ...4.0054
- GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055
- BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...4.0058
- ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...4.0069
- PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA ...4.0074

Stored Grain

- STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS ...2.0067

Survey Methods

- EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...2.0002
- BIOLOGY OF PEST MOSQUITOES, AND CONTROL THROUGH COMMUNITY ACTION ...2.0004
- BIOLOGY OF MICROORGANISMS OF MOSQUITOES ...2.0022
- BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...2.0040
- BIOLOGY AND ECOLOGY OF SALT-MARSH MOSQUITOES OF LOUISIANA ...2.0042
- BIOLOGY AND WATER MANAGEMENT STUDIES FOR CONTROL OF LOUISIANA MOSQUITOES (RICE FIELDS) ...2.0044
- CONTROL OF BLACK FLIES AND MOSQUITOES IN MAINE ...2.0046
- BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS ...2.0054
- INSECT SURVEY OF MONTANA ...2.0058
- SURVEY OF INSECT PROBLEMS IN MONTANA ...2.0059
- MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...2.0060
- COORDINATION OF MOSQUITO CONTROL IN NEW JERSEY ...2.0061
- MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...2.0062
- STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS ...2.0067
- INSECTS AFFECTING MAN ...2.0068
- EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082
- SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...2.0095
- BIOLOGICAL CONTROL OF WEEDS ...2.0102
- NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135
- INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...2.0144
- BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...2.0269
- STUDY THE BIOLOGY OF A GROUP OF SNAIL-KILLING FLIES ...2.0287
- ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE ...4.0031
- TRANSMISSION OF ANAPLASMOSIS ...4.0032
- ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046
- DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053
- ARTHROPOD-BORNE VIRUS (ARBOVIRUS) ACTIVITY IN MAJOR MOSQUITO VECTORS IN IOWA ...4.0057
- MOSQUITOES OF MALAYSIA ...4.0060
- BIONOMICS OF MARYLAND MOSQUITOES ...4.0063
- MOSQUITOES AS VECTORS OF LIVESTOCK DISEASES ...4.0065
- ENTOMOLOGY DEVELOPMENT OF A LIGHTWEIGHT TRAP FOR COLLECTION OF MOSQUITOES FOR VIRUS ISOLATION ...4.0071

Vegetables

- PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...1.0075
- ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

Veterinary Entomology -other

- BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057
- MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...2.0062
- EFFECT OF BITING FLIES ON WEIGHT GAINS IN CATTLE ...2.0090
- ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE ...4.0031
- TRANSMISSION OF ANAPLASMOSIS ...4.0032

Weeds

- SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...2.0095
- BIOLOGICAL CONTROL OF WEEDS ...2.0099
- NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135
- INSECTS ASSOCIATED WITH AQUATIC WEED PESTS OF FOREIGN ORIGIN ...2.0145
- NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188

Entomology, Medical

- EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...1.0249
- BIOLOGY OF PEST MOSQUITOES, AND CONTROL THROUGH COMMUNITY ACTION ...2.0004
- AERIAL DISPERSAL METHODS FOR CONCENTRATED INSECTICIDES ...2.0009
- INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...2.0010
- IDENTIFICATION AND CHARACTERIZATION OF MOSQUITO PATHOGENS ...2.0020
- BIOLOGICAL CONTROL OF INSECTS AFFECTING MAN ...2.0027
- CONTROL OF CULEX NIGRIPALPUS BY STERILITY METHODS ...2.0032

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS ...2.0033
VIRAL PATHOGENS ...2.0035
CYTOPLASMIC INHERITANCE AND CONTROL OF CULEX PIPIENS ...2.0041
BIOLOGY AND ECOLOGY OF SALT-MARSH MOSQUITOES OF LOUISIANA ...2.0042
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043
BIOLOGY AND WATER MANAGEMENT STUDIES FOR CONTROL OF LOUISIANA MOSQUITOES (RICE FIELDS) ...2.0044
GENETIC STUDIES ON THE CONTROL OF ARBOVIRUS VECTORS ...2.0048
BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057
SURVEY OF INSECT PROBLEMS IN MONTANA ...2.0059
COORDINATION OF MOSQUITO CONTROL IN NEW JERSEY ...2.0061
WATER MANAGEMENT IN MOSQUITO IMPOUNDMENTS ...2.0064
MOSQUITO CONTROL IN UPLAND SWAMPS ...2.0065
INSECTS AFFECTING MAN ...2.0068
MODE OF ACTION OF A NEW FUNGAL PATHOGEN OF MOSQUITOES ...2.0070
POTENTIAL OF COELOMOMYCES FOR CONTROLLING MOSQUITOES ...2.0071
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE I ...2.0073
THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078
SUSCEPTIBILITY OR RESISTANCE OF MEDICALLY IMPORTANT INSECTS TO INSECTICIDES ON SELECTED AIR FORCE BASES ...2.0084
ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE ...4.0031
MOSQUITOES OF MIDDLE AMERICA ...4.0037
MOSQUITOES OF MIDDLE AMERICA ...4.0038
ATTRACTIVENESS AND REPELLENCY OF MAN TO MOSQUITO BITES ...4.0041
PUBLICATION OF BIBLIOGRAPHY OF MEDICAL ENTOMOLOGY ...4.0042
INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...4.0059
ENTOMOLOGY DEVELOPMENT OF A LIGHTWEIGHT TRAP FOR COLLECTION OF MOSQUITOES FOR VIRUS ISOLATION ...4.0071

Arthropods and Disease

INVESTIGATIONS OF THE ACTION OF CHEMOSTERILANTS ON HOUSEFLIES AND OTHER MEDICALLY IMPORTANT ARTHROPODS ...2.0026
MALARIA ERADICATION RESEARCH ...2.0051
ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...2.0083
ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044
BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN ...4.0047
BIONOMICS OF SELECTED NORTH AMERICAN CULICINE MOSQUITOES ...4.0054
GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055
ARTHROPOD-BORNE VIRUS (ARBOVIRUS) ACTIVITY IN MAJOR MOSQUITO VECTORS IN IOWA ...4.0057
BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...4.0058
BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS ...4.0061
JAPANESE ENCEPHALITIS ON GUAM ...4.0062
INSECTS AS VECTORS OF DISEASES OF MILITARY IMPORTANCE IN ETHIOPIA THEIR ECOLOGY AND CONTROL ...4.0067
LABORATORY ANALYSIS OF INSECTICIDE EFFECTIVENESS AGAINST MEDICALLY IMPORTANT INSECTS ...4.0068
RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070
ASSESSMENT OF THE IMPORTANCE OF FILARIASIS IN THAILAND ...4.0072
CALIFORNIA ENCEPHALITIS VIRUS IN WISCONSIN ...4.0075

Bloodsucking

ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001
DEVELOPMENT AND BEHAVIOR OF BITING DIPTERA ...2.0023
SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...2.0028
INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...2.0029
MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...2.0062
STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS ...2.0067
THE CONTROL OF MOSQUITOES OF MILITARY IMPORTANCE AND THE PREVENTION OF MOSQUITO-BORNE DISEASES ...2.0074
ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...2.0083
BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...4.0045
ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046
COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...4.0049
DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...4.0051
OCCURRENCE AND BIONOMICS OF BLOODSUCKING MIDGES (DIPTERA: CERATOPOGONIDAE) IN IOWA ...4.0056
BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...4.0058
BIONOMICS OF MARYLAND MOSQUITOES ...4.0063
A STUDY IN INSECT TRANSMISSION OF ANAPLASMOSIS ...4.0064
RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070
PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA ...4.0074

Ectopharasites - No Disease

BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...2.0006
STUDIES ON INSECTICIDE RESISTANCE IN MOSQUITOES ...2.0017
SUPPRESSION AND ECOLOGY OF MOSQUITOES ...2.0018
(U) REPELLENCY AND ATTRACTIVENESS OF MAN TO MOSQUITO BITES ...4.0040

Entomology, Morphology

BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS ...2.0054
BIOLOGICAL STUDIES OF MALACOPHAGOUS DIPTERA ...2.0282
THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...4.0052
RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070
AQUATIC & SEMI-AQUATIC DIPTERA STUDIES ...4.0073

External Morphology

INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...2.0030
FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...2.0053
DEVELOPMENT OF CULTURE METHODS FOR MOSQUITOES ...4.0035
DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...4.0051

Internal Morphology

FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...2.0053

PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA ...4.0074

Polymorphism -insect

THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...4.0052

Entomology, Pathology

MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...2.0019

IDENTIFICATION AND CHARACTERIZATION OF MOSQUITO PATHOGENS ...2.0020

BIOLOGY OF MICROORGANISMS OF MOSQUITOES ...2.0022

BIOLOGICAL CONTROL OF INSECTS AFFECTING MAN ...2.0027

INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...2.0029

CULTIVATION OF COELOMOMYCES, A FUNGAL PARASITE OF MOSQUITOES ...2.0031

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS ...2.0033

FACTORS AFFECTING ROLE OF MICROORGANISMS IN BIOLOGICAL CONTROL OF INSECT PESTS ...2.0037

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043

FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...2.0053

MODE OF ACTION OF A NEW FUNGAL PATHOGEN OF MOSQUITOES ...2.0070

POTENTIAL OF COELOMOMYCES FOR CONTROLLING MOSQUITOES ...2.0071

STUDIES ON SOME FUNGAL PARASITES OF MOSQUITOES ...2.0072

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...2.0079

BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...4.0045

BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS ...4.0061

Entomology, Physiology

Behavior -insect

TOXICOLOGY OF PESTICIDES IN THE ENVIRONMENT ...1.0360

INVESTIGATIONS OF PHEROMONES AS CHEMOSTERILANTS FOR INSECTS WITH SPECIAL REFERENCE TO SYNTHETIC QUEN SUBSTANCE AND ITS ANALOGUES ...2.0021

INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...2.0030

EUROPEAN SCIOMYZIDAE ...2.0283

ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE ...4.0031

THE NUTRITION AND BEHAVIOR OF MOSQUITOES ...4.0033

FEEDING HABITS OF MOSQUITO LARVAE ...4.0034

ATTRACTIVENESS AND REPELLENCY OF MAN TO MOSQUITO BITES ...4.0041

BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN ...4.0047

MOSQUITOES OF THE NEW GUINEA AREA ...4.0050

DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053

GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055

BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS ...4.0061

BIONOMICS OF MARYLAND MOSQUITOES ...4.0063

RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070

AQUATIC & SEMI-AQUATIC DIPTERA STUDIES ...4.0073

Biorhythms -insect

MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...1.0266

SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...2.0055

MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...2.0060

GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055

Circulatory System - Insect

COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...4.0049

Comparative Physiology

STUDY THE BIOLOGY OF A GROUP OF SNAIL-KILLING FLIES ...2.0287

COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...4.0049

Digestion and Excretion

THE NUTRITION AND BEHAVIOR OF MOSQUITOES ...4.0033

FEEDING HABITS OF MOSQUITO LARVAE ...4.0034

COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...4.0049

Endocrine System

MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...1.0266

BIOLOGICAL STUDIES OF MALACOPHAGOUS DIPTERA ...2.0282

GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055

Env Physiology -insect

BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN ...4.0047

THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...4.0052

Growth, Moulting & Metamorph

ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...4.0039

THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...4.0052

WATER QUALITY REQUIREMENTS OF AQUATIC INSECTS ...4.0066

Diapause

DEVELOPMENT AND BEHAVIOR OF BITING DIPTERA ...2.0023

EMERGENCY INSECT CONTROL ...2.0076

BIONOMICS OF SELECTED NORTH AMERICAN CULICINE MOSQUITOES ...4.0054

PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA ...4.0074

Moult and Metamorphosis

BIOLOGY OF MICROORGANISMS OF MOSQUITOES ...2.0022

DEVELOPMENT AND BEHAVIOR OF BITING DIPTERA ...2.0023

BIOLOGY AND WATER MANAGEMENT STUDIES FOR CONTROL OF LOUISIANA MOSQUITOES (RICE FIELDS) ...2.0044

BIOLOGICAL AND BIOCHEMICAL FACTORS INFLUENCING THE DEVELOPMENT OF LARVAL MOSQUITO POPULATIONS ...2.0052

BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057

INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...2.0144

STUDY THE BIOLOGY OF A GROUP OF SNAIL-KILLING FLIES ...2.0287

MOSQUITOES OF MIDDLE AMERICA ...4.0038

ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046

THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...**4.0052**
AQUATIC & SEMI-AQUATIC DIPTERA STUDIES ...**4.0073**

Metabolism -insects
COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...**4.0049**

Musculoskeletal System
MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...**1.0266**

Nervous Systems, Sensory
MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...**1.0266**
BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN ...**4.0047**
DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...**4.0051**

Nutrition -insects
INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...**2.0029**
STUDY THE BIOLOGY OF A GROUP OF SNAIL-KILLING FLIES ...**2.0287**
THE NUTRITION AND BEHAVIOR OF MOSQUITOES ...**4.0033**
FEEDING HABITS OF MOSQUITO LARVAE ...**4.0034**
CULTIVATION OF INSECT PHASE OF AVIAN PLASMODIA ...**4.0036**
ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...**4.0039**
COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...**4.0049**
MOSQUITOES OF THE NEW GUINEA AREA ...**4.0050**
GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...**4.0055**
BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...**4.0058**
BIONOMICS OF MARYLAND MOSQUITOES ...**4.0063**
A STUDY IN INSECT TRANSMISSION OF ANAPLASMOSIS ...**4.0064**
ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...**4.0069**
AQUATIC & SEMI-AQUATIC DIPTERA STUDIES ...**4.0073**

Reproduction - Insect
INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...**2.0010**
BIOLOGICAL STUDIES OF CULICOIDES AND THEIR CONTROL IN THE CANAL ZONE ...**4.0043**
GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...**4.0055**
WATER QUALITY REQUIREMENTS OF AQUATIC INSECTS ...**4.0066**

Female
INVESTIGATIONS OF PHEROMONES AS CHEMOSTERILANTS FOR INSECTS WITH SPECIAL REFERENCE TO SYNTHETIC QUEEN SUBSTANCE AND ITS ANALOGUES ...**2.0021**
BIOLOGY OF MICROORGANISMS OF MOSQUITOES ...**2.0022**
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...**2.0043**
BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN ...**4.0047**
THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...**4.0052**
BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS ...**4.0061**
PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA ...**4.0074**

Male
BIOLOGY OF MICROORGANISMS OF MOSQUITOES ...**2.0022**
MOSQUITOES OF MIDDLE AMERICA ...**4.0037**
THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...**4.0052**
BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS ...**4.0061**

Sterility & Fertility
BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS ...**4.0061**

Respiration -insect
SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...**2.0055**

Sensory -insect
INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...**2.0030**
(U) REPELLENCY AND ATTRACTIVENESS OF MAN TO MOSQUITO BITES ...**4.0040**
BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN ...**4.0047**
DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...**4.0051**

Tissue -insect
DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...**4.0051**
THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...**4.0052**

Environmental Effects

INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...**2.0010**
BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES ...**2.0014**
RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...**2.0161**
DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...**4.0053**

Environmental Health -general

IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD ...**1.0123**
INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...**4.0059**

Environmental Modification

FATE OF HERBICIDES IN PLANTS AND SOILS ...**1.0095**
SURVEY OF INSECT PROBLEMS IN MONTANA ...**2.0059**
AQUATIC PLANTS OF POLLUTED WATERS IN SOUTHWESTERN UNITED STATES ...**4.0028**

Environments

IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD ...**1.0123**
ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN ...**1.0132**
CENTER FOR STUDY OF THE HUMAN ENVIRONMENT ...**1.0190**
WATER MANAGEMENT IN MOSQUITO IMPOUNDMENTS ...**2.0064**
MOSQUITO CONTROL IN UPLAND SWAMPS ...**2.0065**
CONTROLLING MOSQUITOES ON HAYING MEADOWS ...**2.0066**

Environments -geologic
FATE OF HARMFUL METALS IN SOIL AND WATER SYSTEMS ...**1.0003**
CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS ...**1.0042**
IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD ...**1.0123**
ILLINOIS LAWS AFFECTING AGRICULTURE ...**1.0332**

Freshwater Environment

DEVELOP A SELECTIVE ALGACIDE TO CONTROL NUISANCE ALGAL GROWTH ...2.0151

Marine Environments

ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120
CHEMICAL ANALYSES ...1.0129
EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0140
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0158
RESEARCH VESSEL OPERATIONS ...3.0048

Terrestrial Environments

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086

Enzyme Studies

Comparative Enzymology

INHIBITORY EFFECT OF DDT IN ATPASE ASSAY MIXTURES ...1.0309

Enzyme Applications

ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...1.0239
THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM ...1.0350

Enzyme Inhibitor

A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0265
CHARACTERIZATION OF ESTERASE(S) PRESENT IN FISH BLOOD ...1.0276
EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH ...2.0260
CHARACTERIZATION OF THE INFECTIOUS PANCREATIC NECROSIS (IPN) VIRUS OF TROUT ...3.0031

Isoenzymes

EFFECTS OF PESTICIDES ON MARINE ANIMALS ...1.0243

Kinetics - Mechanisms

ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...1.0239
EFFECTS OF PESTICIDES ON MARINE ANIMALS ...1.0243
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0265
CHARACTERIZATION OF ESTERASE(S) PRESENT IN FISH BLOOD ...1.0276

Quantitative & Qualitative

A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0265

Enzymes

ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...1.0239
PHARMACOLOGICAL AND ECOLOGICAL EFFECTS OF PESTICIDES ...1.0362

Alkaline Phosphatase

POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038
EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...2.0234

Aspartate Aminotransferase

EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...2.0234

Atpase

A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0168
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0265
MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...1.0266
INHIBITORY EFFECT OF DDT IN ATPASE ASSAY MIXTURES ...1.0309
EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - ORGANOCHLORINE PESTICIDES AND DISEASE RESISTANCE MECHANISMS OF RAINBOW TROUT ...1.0312
SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...2.0055
ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089

Cholinesterase

ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...1.0239
FACTORS AFFECTING PESTICIDE TOXICITY ...1.0255
COMPARISON OF METHODS USED TO MEASURE ESTERASE ACTIVITY. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...1.0274
SEASONAL CHANGES IN ESTERASE ACTIVITY IN FISH AND INVERTEBRATES. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...1.0275
CHARACTERIZATION OF ESTERASE(S) PRESENT IN FISH BLOOD ...1.0276
EFFECTS OF PARATHION AND MALATHION ON WARM-WATER FISH PONDS ...1.0283
IN VITRO POTENCY OF SEVERAL ANTICHOLINESTERASE AGENTS WITH SELECTED MEMBERS OF THE AQUATIC ENVIRONMENT ...1.0348
RELATION OF APPLICATION METHODS, CONCENTRATION, AND VOLUME OF INSECTICIDE TO CATTLE INSECT CONTROL ...2.0039

Diamine Oxidase

PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...1.0289

Enzymes -nonspecific

LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...1.0212
ENZYME AND TISSUE ALTERATIONS IN FISH - A MEASURE OF WATER QUALITY ...1.0248
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0265
CHRONIC TOXICITY OF PESTICIDES TO FISH ...1.0287
CONSTRUCTION OF PESTICIDES DEGRADABLE BY NORMAL MICROFLORA OF NATURAL WATERS AND SOILS ...1.0331
PHARMACOLOGICAL AND ECOLOGICAL EFFECTS OF PESTICIDES ...1.0362
INSECT CHEMOSTERILANTS ...2.0049
ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089

Esterase

FACTORS AFFECTING PESTICIDE TOXICITY ...1.0255
CHARACTERIZATION OF ESTERASE(S) PRESENT IN FISH BLOOD ...1.0276
IN VITRO POTENCY OF SEVERAL ANTICHOLINESTERASE AGENTS WITH SELECTED MEMBERS OF THE AQUATIC ENVIRONMENT ...1.0348
POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038
ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089
CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS ...2.0265

Glycolytic Enzymes -general

CULTIVATION OF COELOMOMYCES, A FUNGAL PARASITE OF MOSQUITOES ...2.0031

Hydrolytic Enzymes -general

FACTORS AFFECTING PESTICIDE TOXICITY ...1.0255

Luciferase

THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM ...1.0350

Malic Dehydrogenase

POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038

Maltase

COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...4.0049

Microorganism Enzymes

LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...2.0184

Peroxidase

FATE OF PESTICIDES ...1.0064

Proteolytic Enzymes

A STUDY OF INHIBITORY COMPOUNDS PRODUCED BY FRESH-WATER ALGAE ...2.0138

Transaminase

PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...1.0289

PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...1.0290

Trehalase

COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...4.0049

Xanthine Oxidase

POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038

Epizootiology

PATHOLOGY - EPIZOOTIOLOGY ...3.0113

Disease Control & Prevention

INVESTIGATE CONTROL MEASURES OF BACTERIAL INFECTIONS IN FISH ...3.0003

METHOD OF CONTROLLING MORTALITY IN CHANNEL CATFISH DUE TO CCV INFECTION ...3.0005

DEVELOPMENT OF METHODS FOR RAPID IDENTIFICATION OF BACTERIAL FISH PATHOGENS ...3.0097

DIAGNOSIS OF DISEASES IN FISH ...3.0107

PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...3.0108

CHEMOTHERAPEUTIC STUDIES ON FISH PATHOGENIC BACTERIA ...3.0123

CONTROL OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA FILTRATION AND ULTRAVIOLET IRRADIATION ...3.0129

Mass Suppression

THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...1.0359

Quarantine

PACIFIC OYSTER MORTALITY STUDIES ...3.0034

Disease Incidence & Prevalence

IMPACT OF CERATOMYXA IN CENTRAL OREGON SALMONID POPULATIONS ...3.0057

Enzootic

INSECTS AS VECTORS OF DISEASES OF MILITARY IMPORTANCE IN ETHIOPIA THEIR ECOLOGY AND CONTROL ...4.0067

Epizootic

THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...1.0359

EPIZOOTIOLOGY OF PARASITIC DISEASES IN FISH POPULATIONS UNDER INTENSIVE MANAGEMENT ...3.0001

COOPERATIVE FISH PARASITE AND DISEASE STUDY ...3.0015

EPIDERMAL PAPILLOMAS ...3.0021

EPIZOOTIOLOGY OF LEPTOSPIRES - FISH SUSCEPTIBILITY TO L. ICTEROHAEMORRHIGICA (ABBREV) ...3.0023

SURVEY OF ANIMAL DISEASES IN CONNECTICUT ...3.0024

PACIFIC OYSTER MORTALITY STUDIES ...3.0034

ETIOLOGY OF ESTUARINE FISH DISEASES ...3.0040

BIOLOGY OF THE PROTOZOAN PARASITE CERATOMYXA SHASTA ...3.0050

MARINE FISHERIES - SYMBIOSIS AND PARASITISM - RESEARCH ...3.0055

BACTERIAL AND VIRAL DISEASES AND CELL CULTURES OF MARINE FISH AND SHELLFISH ...3.0074

ISOLATION OF VIRUSES FROM FISHES - INVESTIGATION OF FISH EPIZOOTICS OF UNKNOWN ETIOLOGY FOR POSSIBLE VIRUS INVOLVEMENT ...3.0084

MOSQUITOES AS VECTORS OF LIVESTOCK DISEASES ...4.0065

Mode of Disease Transmission

SHELLFISH MORTALITY - CHESAPEAKE BAY ...3.0033

TRANSMISSION OF AN OVARY PARASITE OF THE GOLDEN SHINER ...3.0038

INFECTIOUS DISEASES OF SALMONID FISHES ...3.0049

TRANSMISSION OF CERATOMYXA SHASTA ...3.0058

TRANSMISSION OF MICROSPORIDA ...3.0131

ASSESSMENT OF THE IMPORTANCE OF FILARIASIS IN THAILAND ...4.0072

Congenital

TRANSMISSION OF AN OVARY PARASITE OF THE GOLDEN SHINER ...3.0038

Fomites

TRANSMISSION OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA ...3.0132

Food

THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...1.0359

TRANSMISSION OF AN OVARY PARASITE OF THE GOLDEN SHINER ...3.0038

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045

Invertebrates

THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...1.0359

BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057

THE BIOLOGY AND CONTROL OF THE SNAIL INTERMEDIATE HOST OF SCHISTOSOMES ...2.0276

DEVELOPMENT OF A TOXIC BAIT ...2.0286

PACIFIC OYSTER MORTALITY STUDIES ...3.0034

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045

EPIDEMOLOGY OF 'SALMON POISONING' DISEASE ...3.0054

UTILIZATION OF INVERTEBRATE VECTORS IN THE TRANSMISSION OF WHIRLING DISEASE ...3.0064

TRANSMISSION OF ANAPLASMOSIS ...4.0032

ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046

BIONOMICS OF MARYLAND MOSQUITOES ...4.0063

A STUDY IN INSECT TRANSMISSION OF ANAPLASMOSIS ...4.0064

Vertebrates

- THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...1.0359
- IDENTIFICATION OF PARASITIC BACTERIAL FORMS ...3.0002
- SUSCEPTIBILITY OF OTHER SPECIES OF CATFISHES TO CCV AND THEIR POSSIBLE ROLE AS CARRIERS ...3.0007
- DETERMINE IF SPORES OR INFECTIVE STAGES ARE SHED FROM LIVING FISH ...3.0068
- DETECTION OF CARRIER CONDITION IN FURUNCULOSIS ...3.0098
- POSSIBLE BIRD TRANSMISSION OF 'MYXOSOMA CEREBRALIS' ...3.0105

Water

- BIOLOGY OF THE PROTOZOAN PARASITE CERATOMYXA SHASTA ...3.0050
- CONTROL OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA FILTRATION AND ULTRAVIOLET IRRADIATION ...3.0129

Vector-host Relationship

Biological

- THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078
- TRANSMISSION OF ANAPLASMOSIS ...4.0032
- INSECTS AS VECTORS OF DISEASES OF MILITARY IMPORTANCE IN ETHIOPIA THEIR ECOLOGY AND CONTROL ...4.0067

Mechanical

- COOPERATIVE FISH PARASITE AND DISEASE STUDY ...3.0015

Zoonotic

- VERTEBRATE DISEASES - VIRAL DISEASES OF FRESHWATER FISHES AND OTHER LOWER VERTEBRATES EGTVED VIRUS ...3.0104
- ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044

Erosion Control

- WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...1.0005
- ECONOMIC EFFECTS OF PESTICIDES AND OTHER WASTES ON NATURAL RESOURCE QUALITY ...1.0026
- PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...1.0033
- PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0085
- PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...1.0090
- FERTILIZERS AND SEDIMENTS AS WATER POLLUTANTS ...1.0179

Wind Erosion

- EVALUATION AND DEMONSTRATION OF IRRIGATION METHODS AND PRACTICES TO REDUCE CONTAMINATION IN IRRIGATION WASTE WATER ...1.0104

Estuaries

- ENVIRONMENTAL BIOLOGY - BIOGEOCHEMICAL CYCLING IN ECOLOGICAL SYSTEMS ...1.0068
- PESTICIDE KINETICS ...1.0127
- ESTUARINE ECOSYSTEMS ...1.0128
- CHEMICAL ANALYSES ...1.0129
- EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133
- TOXAPHENE CONTAMINATION - ESTUARINE ECOLOGY ...1.0139
- DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...1.0184
- TRANSFER OF PESTICIDES THROUGH SOILS, WATER, SEDIMENTS AND AQUATIC LIFE ...1.0202
- THE OCCURRENCE OF PESTICIDE RESIDUES IN THE LOWER BRISBANE RIVER AND IN THE TISSUES OF ESTUARINE ANIMALS ...1.0233
- EFFECTS OF PESTICIDES ON AQUATIC ANIMALS IN THE ESTUARINE AND MARINE ENVIRONMENTS ...1.0234
- PESTICIDE MONITORING PROGRAM ...1.0238
- ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...1.0239
- BEHAVIOR OF ESTUARINE ANIMALS ...1.0240
- PHYSIOLOGY OF ESTUARINE ORGANISMS ...1.0242
- THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...1.0253
- PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES ...1.0254
- EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0304
- EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0305
- PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...1.0358
- COORDINATION OF MOSQUITO CONTROL IN NEW JERSEY ...2.0061
- EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE I ...2.0073
- EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...2.0075
- VIBRIO PARAHAEMOLYTICUS IN CHESAPEAKE BAY - ISOLATION, INCIDENCE AND PATHOGENICITY ...3.0026
- UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029
- ETIOLOGY OF ESTUARINE FISH DISEASES ...3.0040
- ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...3.0052
- MARINE FISHERIES - SYMBIOSIS AND PARASITISM - RESEARCH ...3.0055
- EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...3.0083

Ethers

- EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...2.0234
- THE EFFECTS OF DIFFERENTLY EXTRACTED ENDOTOXINS FROM ESCHERICHIA COLI ON RAINBOW TROUT (SALMO GAIRDNERI) ...3.0071

Ethiopia

- INSECTS AS VECTORS OF DISEASES OF MILITARY IMPORTANCE IN ETHIOPIA THEIR ECOLOGY AND CONTROL ...4.0067

Eutrophication

- NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0027
- ENVIRONMENTAL BIOLOGY - BIOGEOCHEMICAL CYCLING IN ECOLOGICAL SYSTEMS ...1.0068
- GREEN BAY RESEARCH PROGRAM ...1.0112
- AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161
- WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...1.0162
- GROUND AND SURFACE WATERS - POLLUTION ...1.0182
- ALGAE CONTROL BY ARTIFICIAL MIXING IN LAKE COCHITUATE ...2.0149
- EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168
- EUTROPHICATION - EFFECT OF WEED HARVESTING ...2.0169
- EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...2.0170

EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...2.0171

EUTROPHICATION - PILOT OPERATIONS ...2.0172

NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180

IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...2.0181

LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...2.0184

LIMNOLOGICAL, ICHTHYOLOGICAL, AND PARASITOLOGICAL INVESTIGATIONS ON ARKANSAS RESERVOIRS IN RELATION TO WATER QUALITY ...3.0019

INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...4.0001

RELATIVE LEACHING RATES OF COMMON NITROGEN CARRIERS FROM SANDY SOILS IN RELATION TO LAKE EUTROPHICATION ...4.0006

AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...4.0011

NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...4.0015

LAKE SUPERIOR PERIPHYTON IN RELATION TO WATER QUALITY ...4.0017

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...4.0018

RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...4.0019

EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029

ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...4.0069

Evapotranspiration

EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...1.0074

Extracts

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053

CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS ...2.0265

Exudates

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082

Farm Pond -see Ponds

REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...1.0047

RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS ...1.0138

CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...1.0189

MICROBIOLOGY OF FARM PONDS ...1.0220

PHYSICAL AND CHEMICAL FACTORS AFFECTING FISH ...1.0246

ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...1.0339

FARM FISH POND MANAGEMENT ...1.0340

AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...1.0343

DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...2.0094

CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101

BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115

FOREST AND FARM GAME HABITAT; FISH POND ...2.0143

Farm Safety

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...1.0032

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...1.0052

METHODS FOR DISPOSAL OF SPILLED AND UNUSED PESTICIDES ...1.0060

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086

CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0093

Farm Wastes

ECONOMIC EFFECTS OF PESTICIDES AND OTHER WASTES ON NATURAL RESOURCE QUALITY ...1.0026

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183

IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...2.0181

IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION ...2.0182

Fats

CONTAMINATION OF CHANNEL CATFISH WITH DIELDRIN FROM AGRICULTURAL RUNOFF ...1.0247

QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...1.0259

THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...1.0297

THE RELATIONSHIP BETWEEN THE USE OF AGRICULTURAL CHLORINATED HYDROCARBONS AND THEIR RESIDUES IN CHANNEL CATFISH ...1.0298

PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES ...1.0306

FISHERY RESOURCES PROGRAM ...1.0317

CHEMICAL BIOCIDES IN LAKES ...1.0364

PESTICIDE LEVELS IN BIRDS WINTERING ON LAKE MICHIGAN ...1.0367

SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...2.0028

INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...2.0030

CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...2.0160

(U) REPELLENCY AND ATTRACTIVENESS OF MAN TO MOSQUITO BITES ...4.0040

ATTRACTIVENESS AND REPELLENCY OF MAN TO MOSQUITO BITES ...4.0041

PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA ...4.0074

Blood Lipids -general

BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH ...1.0261

Glycerides

COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...4.0049

Glycolipids

THE EFFECTS OF DIFFERENTLY EXTRACTED ENDOTOXINS FROM ESCHERICHIA COLI ON RAINBOW TROUT (SALMO GAIRDNERI) ...3.0071

Plant Lipids

CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266

Feces

REDUCTION OF PESTICIDE RESIDUE HAZARDS ...1.0040

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260

DETERMINE IF SPORES OR INFECTIVE STAGES ARE SHED FROM LIVING FISH ...3.0068

POSSIBLE BIRD TRANSMISSION OF 'MYXOSOMA CEREBRALIS' ...3.0105

Fencholic Acid

BIOLOGICAL EVALUATION OF INSECT CONTROL AGENTS ...2.0050

Fertilizer Technology

Fertilizer Losses

SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072

NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073

FATES OF AGRICULTURAL CHEMICALS IN SOILS ...1.0092

EVALUATION AND DEMONSTRATION OF IRRIGATION METHODS AND PRACTICES TO REDUCE CONTAMINATION IN IRRIGATION WASTE WATER ...1.0104

QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204

RELATIVE LEACHING RATES OF COMMON NITROGEN CARRIERS FROM SANDY SOILS IN RELATION TO LAKE EUTROPHICATION ...4.0006

Fertilizer Materials

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008

NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073

EVALUATION AND DEMONSTRATION OF IRRIGATION METHODS AND PRACTICES TO REDUCE CONTAMINATION IN IRRIGATION WASTE WATER ...1.0104

RELATIVE LEACHING RATES OF COMMON NITROGEN CARRIERS FROM SANDY SOILS IN RELATION TO LAKE EUTROPHICATION ...4.0006

Placement of Fertilizer

AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...1.0186

Rates or Levels of Application

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008

SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072

NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073

LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION ...1.0178

AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...1.0186

RELATIVE LEACHING RATES OF COMMON NITROGEN CARRIERS FROM SANDY SOILS IN RELATION TO LAKE EUTROPHICATION ...4.0006

Timing of Application

NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073

AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...1.0186

Types of Applied Fertilizer

EVALUATION AND DEMONSTRATION OF IRRIGATION METHODS AND PRACTICES TO REDUCE CONTAMINATION IN IRRIGATION WASTE WATER ...1.0104

Filtration

REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...1.0047

PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166

CONCENTRATION AND ANALYSIS OF PESTICIDES AND OTHER RECALCITRANT MOLECULES IN WATER SUPPLIES BY ULTRAFILTRATION ...1.0185

ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211

INFECTIOUS DISEASES OF SALMONID FISHES ...3.0049

Fish

Acipenseridae

FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES ...4.0080

Agnatha

RESIDUES OF TFM IN FISH--LA CROSSE ...1.0315

STUDY OF THE SEA LAMPREY IN LOVE LAKE ...2.0200

ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202

SEA LAMPREY CONTROL - LAKE MICHIGAN CHEMICAL CONTROL ...2.0203

SEA LAMPREY CONTROL - LAKE HURON CHEMICAL CONTROL ...2.0204

LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...2.0205

SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...2.0206

SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...2.0207

SEA LAMPREY CONTROL - ASSESSMENT METHODS ...2.0208

LAKE HURON CHEMICAL CONTROL ...2.0209

BIOLOGY OF THE LARVAL SEA LAMPREY ...2.0210

BIOASSAY ...2.0211

LAKE SUPERIOR COMMERCIAL FISHERIES ASSESSMENT STUDIES ...2.0212

RELATION OF LAMPREY EELS TO EXISTING SALMONID STOCKS IN CAYUGA LAKE ...2.0219

TRIBUTARY SURVEY OF LAKES ONTARIO AND ERIE ...2.0220

PLANNING FOR CREATION OF SALMONID FISHERIES IN LAKE ONTARIO ...2.0221

PRE-LAMPREY CONTROL INVENTORY OF FISH STOCKS ...2.0222

POPULATION DYNAMICS - LAKE TROUT ...2.0235

THE DEVELOPMENT OF ANALYTICAL METHODS CAPABLE OF MEASURING TFM RESIDUES IN FISH, WATER, AND OTHER COMPLEX SUBSTRATES ...2.0238

ASSESSMENT OF LAKE TROUT AND ASSOCIATED SPECIES IN LAKES MICHIGAN AND SUPERIOR ...2.0264

Carangidae

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029

SPAWNING AND REARING OF MARINE FISH ...3.0110

Catostomidae

FISHERIES UNIT ...1.0203

JO-MARY POND RECLAMATION ...2.0201

THE INTERACTION OF THE WALLEYE AND WHITE SUCKER IN THE FISH POPULATION OF SOFT WATER LAKE IN NORTHEASTERN MINNESOTA ...2.0215

THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...2.0252

STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0255

CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0259
GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081

Centrarchidae

Centrarchidae -other
METABOLISM OF ENDRIN IN PONDS ...1.0113
THE SUSCEPTIBILITY OF VARIOUS LIFE STAGES OF FRESHWATER FISHES TO THREE TOXICANTS ...1.0279
RELATIVE SUSCEPTIBILITIES OF FISH FAMILIES TO HERBICIDES ...1.0280
EFFECTS OF PARATHION AND MALATHION ON WARMWATER FISH PONDS ...1.0283
UPTAKE AND METABOLISM BY FISH OF 2,4-D DIMETHYL AMINE SALT ...1.0293
EVALUATION OF GIZZARD SHAD AS A FORAGE FISH ...1.0356
FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...2.0142
SMALL IMPOUNDMENT STOCKING ...2.0190
IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...3.0018
CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045

Lepomis -other
STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0255
CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0259

Lepomis Macrochirus
UPTAKE AND RELEASE OF DALAPON IN EARTHEN PONDS ...1.0114
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0168
MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...1.0266
COMPARISON OF METHODS USED TO MEASURE ESTERASE ACTIVITY. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...1.0274
SEASONAL CHANGES IN ESTERASE ACTIVITY IN FISH AND INVERTEBRATES. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...1.0275
EARLY SQUAMATION OF BLUEGILL (LEPOMIS MACROCHIRUS) AND FATHEAD MINNOWS (PIMEPHALES PROMELAS) EXPOSED TO AROCLORS ...1.0286
CHRONIC TOXICITY OF PESTICIDES TO FISH ...1.0287
MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...1.0292
UPTAKE AND METABOLISM BY FISH OF 2,4-D DIMETHYL AMINE SALT ...1.0293
THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0330
STUDY OF CHRONIC TOXICITY OF LINDANE TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0337
DETERMINATION OF DIGESTION RATES FOR TROUT ...1.0346
POND ECOLOGY AND PRODUCTION AS AFFECTED BY SIMAZINE ...1.0353
EVALUATION OF GIZZARD SHAD AS A FORAGE FISH ...1.0356
STUDY OF CHRONIC TOXICITY OF PARATHION TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0357
RESTORING 'BALANCE' WITH ROTENONE AND FINTROL ...2.0194
THE TOXICITY AND DETOXIFICATION OF THE ROTENONE FORMULATIONS USED IN FISH MANAGEMENT ...2.0226
AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO ...2.0227
U.V. SPECTROPHOTOMETRY FOR THE IDENTIFICATION AND ESTIMATION OF QUINALDINE RESIDUE ...2.0237
THE EFFICACY OF QUINALDINE SULFATE - MS-222 AS AN ANESTHETIC FOR FISH IN THE LABORATORY - WARM SPRINGS ...2.0239
SELECTIVE REMOVAL OF VARIOUS FISH SPECIES WITH ANTIMYCIN ...2.0240
STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0255
CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0259
THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...2.0261
CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045
IMMUNODIAGNOSIS OF WHIRLING DISEASE (MYXOSOMA CEREBRALIS) ...3.0103
SURVEYS FOR PANFISH CONTROL STUDIES ...4.0086

Micropterus Dolomieui
IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...3.0018

Micropterus Salmoides
UPTAKE AND RELEASE OF DALAPON IN EARTHEN PONDS ...1.0114
EVALUATION OF GIZZARD SHAD AS A FORAGE FISH ...1.0356
AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO ...2.0227
EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT) ...2.0229
MERIDIAN STATE PARK LAKE CRAPPIE REMOVAL EXPERIMENT ...2.0231
THE EFFICACY OF QUINALDINE SULFATE - MS-222 AS AN ANESTHETIC FOR FISH IN THE LABORATORY - WARM SPRINGS ...2.0239
SELECTIVE REMOVAL OF VARIOUS FISH SPECIES WITH ANTIMYCIN ...2.0240
DEVELOPMENTS OF METHODS RELATED TO TESTING OF FISH CONTROL AGENTS BIOCHEMICAL METHOD FOR SEXING FISH ...2.0248
THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...2.0261
IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...3.0018
LIMNOLOGICAL, ICHTHYOLOGICAL, AND PARASITOLOGICAL INVESTIGATIONS ON ARKANSAS RESERVOIRS IN RELATION TO WATER QUALITY ...3.0019
A STUDY OF THE INTERACTION OF THREE SPECIES OF BULLHEAD AND ASSOCIATED GAME FISH SPECIES IN A SINGLE LAKE ...4.0079

Pomoxis Spp.
EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT) ...2.0229
MERIDIAN STATE PARK LAKE CRAPPIE REMOVAL EXPERIMENT ...2.0231

Chondrichthyes

Selachii
STUDIES OF SHARK REPELLENTS AND OTHER ANTISHARK MEASURES ...2.0191

Cichlidae
NERVE IMPULSE TRANSMISSION CHARACTERISTICS OF ISOLATED FISH-NERVE PREPARATIONS PERFUSED WITH PHYSIOLOGICAL LEVELS OF SELECTED PESTICIDES ...1.0271
THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0330
AQUATIC WEED CONTROL BY POND FISHES ...2.0139
INVESTIGATIONS OF AMEBIASIS IN FISH ...3.0014

Clupidae

Alosa Spp.
FISHERY RESOURCES PROGRAM ...1.0317
MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...3.0106

Clupeidae -other
ACCUMULATION OF PESTICIDES IN MENHADEN ...1.0299

LAKE SUPERIOR COMMERCIAL FISHERIES ASSESSMENT STUDIES ...2.0212

Dorosoma Spp.

EVALUATION OF GIZZARD SHAD AS A FORAGE FISH ...1.0356

HAUL SEINE STUDY ...2.0192

STRIPED BASS STUDIES ...2.0193

SPAWNING AND REARING OF MARINE FISH ...3.0110

GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081

Cottidae

FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES ...4.0080

Cyprinidae

Carassius Auratus

METABOLISM OF ENDRIN IN PONDS ...1.0113

EFFECT OF ENDRIN ON EGG-SPERM FORMATION AND EMBRYONIC DEVELOPMENT ...1.0229

EFFECTS ON THE SPERMIATION RESPONSE OF GOLDFISH AFTER EXPOSURE TO SELECTED PESTICIDES ...1.0270

EFFECTS OF TOXICANTS UPON FISH MOVEMENT PATTERNS ...1.0308

TIME-CONCENTRATION TESTS INVOLVING NEUTRALIZATION OF ROTENONE WITH POTASSIUM PERMANGANATE ...2.0224

STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0255

CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0259

Cyprinidae -other

RELATIVE SUSCEPTIBILITIES OF FISH FAMILIES TO HERBICIDES ...1.0280

SQUAWFISH CONTROL IN CASCADE RESERVOIR ...2.0195

SOUAWFISH STUDIES--ST. JOE RIVER, IDAHO ...2.0196

SURVIVAL AND GROWTH OF KOKANEE AND COHO SALMON IN ANDERSON RANCH RESERVIOR ...2.0197

JO-MARY POND RECLAMATION ...2.0201

LAKE SUPERIOR COMMERCIAL FISHERIES ASSESSMENT STUDIES ...2.0212

PISCICIDE TOXICOLOGY OF THE CYPRINIDS IN EAST AND WEST PAULINA LAKES ...2.0228

LIFE HISTORY OF ST. JOE RIVER CUTTHROAT TROUT ...4.0077

FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES ...4.0080

REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES ...4.0083

Cyprinus Carpio

PESTICIDE RESIDUES IN KANSAS STREAMS ...1.0150

THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...2.0130

EXPERIMENTAL INTRODUCTION OF EXOTIC FRESHWATER FISHES ...2.0131

AQUATIC WEED CONTROL BY POND FISHES ...2.0139

THE USE OF PHEROMONES BY CARP, CYPRINUS CARPIO-RESEARCH ...2.0217

TIME-CONCENTRATION TESTS INVOLVING NEUTRALIZATION OF ROTENONE WITH POTASSIUM PERMANGANATE ...2.0224

AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO ...2.0227

EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT) ...2.0229

THE EFFICACY OF QUINALDINE SULFATE - MS-222 AS AN ANESTHETIC FOR FISH IN THE LABORATORY - WARM SPRINGS ...2.0239

THE EFFICACY OF MONSANTO NO. 51294 AS A FISH TOXICANT (LABORATORY) ...2.0243

METABOLISM AND EXCRETION OF TFM ...2.0251

THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...2.0252

THE EFFECTS OF THANITE ON THE ACID-BASE BALANCE IN THE BLOOD OF FISHES ...2.0254

STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0255

CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0259

GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081

Minnows

STREAM STUDIES TO DETERMINE TOXIC EFFECTS OF METHOXYCHLOR IN FISH POPULATIONS ...1.0263

LABORATORY BIOASSAYS TO DETERMINE TOXIC EFFECS OF METHOXYCHLOR IN FISH ...1.0264

EARLY SQUAMATION OF BLUEGILL (LEPOMIS MACROCHIRUS) AND FATHEAD MINNOWS (PIMEPHALES PROMELAS) EXPOSED TO AROCLORS ...1.0286

STUDY OF CHRONIC TOXICITY OF LINDANE TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0337

STUDY OF CHRONIC TOXICITY OF PARATHION TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0357

EXPERIMENTAL ESTABLISHMENT OF MONOSPECIFIC WALLEYE POPULATIONS AS A MANAGEMENT MEASURE FOR SMALL WARMWATER LAKES IN NORTHERN MINNESOTA ...2.0214

REFINEMENT OF MANAGEMENT TECHNIQUES FOR STREAM TROUT LAKES ...3.0035

EXPERIMENTAL CONTROL OF NEASCUS IN SMALL TROUT LAKES ...3.0036

Notropis Spp.

DETERMINATION OF DIGESTION RATES FOR TROUT ...1.0346

EVALUATION OF GIZZARD SHAD AS A FORAGE FISH ...1.0356

TRANSMISSION OF AN OVARY PARASITE OF THE GOLDEN SHINER ...3.0038

Cyprinodontidae

RELATIONSHIPS BETWEEN SUB-LETHAL PESTICIDES AND REPRODUCTION AND BEHAVIOR OF FISHES ...1.0245

BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...2.0006

BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES ...2.0014

INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025

AQUATIC PLANT CONTROL BY HERBIVOROUS AMUR FISH ...2.0092

EXPERIMENTAL CONTROL OF NEASCUS IN SMALL TROUT LAKES ...3.0036

Embiotocidae

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0304

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0305

MARINE FISHERIES - SYMBIOSIS AND PARASITISM - RESEARCH ...3.0055

Esocidae

DETERMINATION OF DIGESTION RATES FOR TROUT ...1.0346

THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...2.0252

WALLEYE AND NORTHERN PIKE STUDY ...3.0072

A STUDY OF THE INTERACTION OF THREE SPECIES OF BULLHEAD AND ASSOCIATED GAME FISH SPECIES IN A SINGLE LAKE ...4.0079

GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081

NORTHERN PIKE LIFE HISTORY STUDY ...4.0084

Fish -nonspecific

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0037

RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...1.0057
DEVELOPMENT OF ON-SITE BIOASSAY METHODS ...1.0108
RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS ...1.0138
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0140
PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...1.0143
GREAT LAKES PESTICIDE MONITORING PROGRAM, INDIANA ...1.0147
GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0158
MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...1.0160
PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166
CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...1.0205
OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...1.0219
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0228
EFFECT OF ENDRIN ON FISH AND THEIR ENVIRONMENT UNDER CONTROLLED CONDITIONS ...1.0230
PESTICIDES RESEARCH ...1.0232
THE OCCURRENCE OF PESTICIDE RESIDUES IN THE LOWER BRISBANE RIVER AND IN THE TISSUES OF ESTUARINE ANIMALS ...1.0233
EFFECTS OF PESTICIDES ON AQUATIC ANIMALS IN THE ESTUARINE AND MARINE ENVIRONMENTS ...1.0234
CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...1.0235
RESEARCH STUDY ON THE EFFECTS OF POLLUTION ON SUB-TROPICAL FISH AND CRUSTACEANS ...1.0237
PESTICIDE MONITORING PROGRAM ...1.0238
BEHAVIOR OF ESTUARINE ANIMALS ...1.0240
LABORATORY BIOASSAYS ...1.0241
FACTORS AFFECTING PESTICIDE TOXICITY ...1.0255
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0265
CHARACTERIZATION OF ESTERASE(S) PRESENT IN FISH BLOOD ...1.0276
SCREENING OF PESTICIDES AGAINST FISH AT COLUMBIA MISSOURI ...1.0277
THE INFLUENCES OF ENVIRONMENTAL CONDITIONS ON THE TOXICITY OF PESTICIDES ...1.0278
CHRONIC EFFECTS OF DURSBAN ON WARM-WATER FISH ...1.0282
CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...1.0285
PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...1.0289
PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...1.0290
PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0291
THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...1.0297
TOXICITY OF SELECTED METALS TO CONDITIONED FISH ...1.0302
PESTICIDE TOXICITY TO MARINE FISH AND INVERTEBRATES ...1.0307
INHIBITORY EFFECT OF DDT IN ATPASE ASSAY MIXTURES ...1.0309
EFFECT OF PESTICIDE RESIDUES ON GAME FISH POPULATIONS ...1.0310
RESIDUES OF THANITE IN FISH MUSCLE ...1.0314
RESIDUES OF TFM IN FISH--LA CROSSE ...1.0315
STATIC BIOASSAY OF TRACERS AND DYES AGAINST FISH AND INVERTEBRATES ...1.0316
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319
REPRODUCTIVE PERFORMANCE OF FISH-EATING BIRDS IN NORTHERN CALIFORNIA ...1.0320
PESTICIDES AND WILDLIFE ...1.0324
ECOLOGICAL STUDIES OF WILDLIFE MANAGEMENT PRACTICES ...1.0327
FATE OF AQUATIC HERBICIDES IN THE AQUATIC ENVIRONMENT ...1.0329
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0334
ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...1.0339
BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342
IN VITRO POTENCY OF SEVERAL ANTICHOLINESTERASE AGENTS WITH SELECTED MEMBERS OF THE AQUATIC ENVIRONMENT ...1.0348
INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0351
PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...1.0358
CHEMICAL BIOCIDES IN LAKES ...1.0364
STUDY ON THE EFFECTS OF FISH TOXICANTS ANTIMYCIN A AND ROTENONE ON POND COMMUNITIES ...1.0366
INSECTICIDES AND EGG-SHELL DEPOSITION ...1.0368
CHEMICAL CONTROL OF WEEDS IN PONDS ...2.0093
CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101
AQUATIC PLANT CONTROL ...2.0128
EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...2.0170
EXPERIMENTAL USE OF PESTICIDES FOR FISHERIES MANAGEMENT PURPOSES ...2.0189
BIOLOGICAL AND LIMNOLOGICAL INVENTORY OF SEVEN FLOOD CONTROL RESERVOIRS IN THE STATE OF INDIANA ...2.0199
NEUTRALIZATION OF ROTENONE WITH ACTIVATED CHARCOAL ...2.0225
FISH TOXICANT STUDIES ...2.0232
RESIDUES OF MS-222 IN FISH ...2.0236
U.V. SPECTROPHOTOMETRY FOR THE IDENTIFICATION AND ESTIMATION OF QUINALDINE RESIDUE ...2.0237
THE DEVELOPMENT OF ANALYTICAL METHODS CAPABLE OF MEASURING TFM RESIDUES IN FISH, WATER, AND OTHER COMPLEX SUBSTRATES ...2.0238
THE EFFICACY OF THANITE (ISOBORNYL THIOCYANOACETATE) AS A FISH COLLECTION AID ...2.0242
THE EFFICACY AND PERSISTENCE OF FORMULATIONS OF ANTIMYCIN ...2.0244
DEVELOPMENT OF RHODAMINE-B DYE TO TRACE FLOW AND DISPERSION PATTERNS IN STREAMS AS AN ADJUNCT TO TREATING STREAMS WITH FISH-CONTROL CHEMICALS ...2.0245
THE EFFICACY OF NEW FORMULATIONS OF ANTIMYCIN IN NATURAL LAKES AND STREAMS ...2.0246
ESTABLISH MINIMUM DOSES OF ANTIMYCIN AND ROTENONE NEEDED FOR TOTAL KILLS OF TARGET FISHES ...2.0247
THE EFFECTS OF THANITE ON THE INORGANIC BLOOD CHEMISTRIES OF FISHES ...2.0253
STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES ...2.0256
STATIC BIOASSAY OF COLLECTING AIDS AGAINST FISH ...2.0257
STATIC BIOASSAY OF ATTRACTANTS AND REPELLANTS AGAINST FISH AND INVERTEBRATES ...2.0258
IDENTIFICATION OF PARASITIC BACTERIAL FORMS ...3.0002
INVESTIGATE CONTROL MEASURES OF BACTERIAL INFECTIONS IN FISH ...3.0003
DEVELOPMENT OF NEW FISH CELL LINES ...3.0008
DISTRIBUTION OF THE GENUS ERGASILUS (PARASITIC COPEPOD) IN THE SOUTHEASTERN UNITED STATES ...3.0011
COOPERATIVE FISH DISEASE PROJECT ...3.0012
COOPERATIVE FISH PARASITE AND DISEASE STUDY ...3.0015
PUBLICATION OF FISH BACTERIAL RESEARCH ...3.0016

PUBLICATION OF FISH VIRUS RESEARCH ...**3.0017**
STUDY OF THE INCIDENCE AND LIFE CYCLES OF MYXOSPORIDIAL INFECTIONS IN WARM WATER FISHES (REVISED) ...**3.0020**
EPIZOOTIOLOGY OF LEPTOSPIRES - FISH SUSCEPTIBILITY TO L. ICTEROHAEMORRHIGICA (ABBREV) ...**3.0023**
DISEASES OF FISH ...**3.0025**
PATHOLOGY RESEARCH ...**3.0027**
ENVIRONMENTAL STUDY ...**3.0030**
IDENTIFICATION OF PARASITES AND DISEASES EFFECTING MARICULTURE SPECIES ...**3.0037**
ETIOLOGY OF ESTUARINE FISH DISEASES ...**3.0040**
PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...**3.0047**
RESEARCH VESSEL OPERATIONS ...**3.0048**
TRANSMISSION OF CERATOMYXA SHASTA ...**3.0058**
VIRAL DISEASES OF MARINE FISHES ...**3.0061**
MARINE FISH-CULTURE PATHOLOGY ...**3.0070**
ISOLATION OF VIRUSES FROM FISHES - INVESTIGATION OF FISH EPIZOOTICS OF UNKNOWN ETIOLOGY FOR POSSIBLE VIRUS INVOLVEMENT ...**3.0084**
CYTOPATHOGENIC EFFECT OF TOXIN ON TISSUE ...**3.0086**
CYTOPATHOGENIC EFFECT OF TOXIN IN FISH ...**3.0087**
CORRELATE NITROGEN GAS CONTENT OF WATER SUPPLIES WITH DISEASE ...**3.0088**
BACTERIOLOGICAL AND SEROLOGICAL STUDIES ON MOTILE AEROMONADS AND PSEUDOMONADS FRESHLY ISOLATED FROM DISEASED FISHES ...**3.0096**
DEVELOPMENT OF METHODS FOR RAPID IDENTIFICATION OF BACTERIAL FISH PATHOGENS ...**3.0097**
PARASITOLOGY - PARASITES AND PARASITIC DISEASES OF FISHES - IMMUNIZATION STUDY FOR ICHTHYOPHTHIRIUS ...**3.0100**
ISOLATION AND FURTHER DESCRIPTION OF THE SPORES OF MYXOSOMA CEREBRALIS ...**3.0101**
DIAGNOSIS OF DISEASES IN FISH ...**3.0107**
IN VIVO CHEMOTHERAPEUTIC STUDIES ON FISH PATHOGENIC BACTERIA ...**3.0121**
CHEMOTHERAPEUTIC STUDIES ON FISH PATHOGENIC BACTERIA ...**3.0123**
CHEMOTHERAPY OF FISH DISEASES ...**3.0127**
PARASITES AND PARASITIC DISEASES OF FISHES - STUDY OF NEW METHODS FOR CONTROL OF ICHTHYOPHT ...**3.0128**
TRANSMISSION OF MICROSPORIDA ...**3.0131**
DIAGNOSIS OF DISEASES IN WILDLIFE ...**3.0134**
EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...**4.0029**
INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...**4.0059**
ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...**4.0069**
POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIPMINE LAKES IN SOUTHEAST KANSAS ...**4.0078**
LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN ...**4.0082**

Ictaluridae

Bullheads
SMALL IMPOUNDMENT STOCKING ...**2.0190**
TIME-CONCENTRATION TESTS INVOLVING NEUTRALIZATION OF ROTENONE WITH POTASSIUM PERMANGANATE ...**2.0224**
AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO ...**2.0227**
EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT) ...**2.0229**
THE EFFICACY OF MONSANTO NO. 51294 AS A FISH TOXICANT (LABORATORY) ...**2.0243**
STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...**2.0255**
CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...**2.0259**
THE EFFECTS OF ANTIMYCIN A ON THE METABOLISM OF SELECTED TISSUES IN FISH (ABBREV) ...**2.0262**
CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS ...**2.0265**
SUSCEPTIBILITY OF OTHER SPECIES OF CATFISHES TO CCV AND THEIR POSSIBLE ROLE AS CARRIERS ...**3.0007**
A STUDY OF THE INTERACTION OF THREE SPECIES OF BULLHEAD AND ASSOCIATED GAME FISH SPECIES IN A SINGLE LAKE ...**4.0079**

Ictaluridae -other
METABOLISM OF ENDRIN IN PONDS ...**1.0113**
NERVE IMPULSE TRANSMISSION CHARACTERISTICS OF ISOLATED FISH-NERVE PREPARATIONS PERFUSED WITH PHYSIOLOGICAL LEVELS OF SELECTED PESTICIDES ...**1.0271**
THE SUSCEPTIBILITY OF VARIOUS LIFE STAGES OF FRESHWATER FISHES TO THREE TOXICANTS ...**1.0279**
RELATIVE SUSCEPTIBILITIES OF FISH FAMILIES TO HERBICIDES ...**1.0280**
THE EFFECT OF DIELDRIN ON SURVIVAL AND DEVELOPMENT OF FISH EGGS ...**1.0300**
AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO ...**2.0227**
EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT) ...**2.0229**
U.V. SPECTROPHOTOMETRY FOR THE IDENTIFICATION AND ESTIMATION OF QUINALDINE RESIDUE ...**2.0237**
INTENSIVE SCREENING OF POTENTIAL FISH CONTROL AGENTS - POTENTIATION OF ANTIMYCIN ...**2.0241**
CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS ...**2.0265**
SUSCEPTIBILITY OF OTHER SPECIES OF CATFISHES TO CCV AND THEIR POSSIBLE ROLE AS CARRIERS ...**3.0007**

Ictalurus Punctatus
UPTAKE AND RELEASE OF DALAPON IN EARTHEN PONDS ...**1.0114**
PESTICIDE RESIDUES IN KANSAS STREAMS ...**1.0150**
EFFECT OF ENDRIN ON EGG-SPERM FORMATION AND EMBRYONIC DEVELOPMENT ...**1.0229**
PRELIMINARY STUDIES ON ENDRIN AND OTHER PESTICIDE UPTAKES BY FINGERLING CHANNEL CATFISH ...**1.0231**
PHYSICAL AND CHEMICAL FACTORS AFFECTING FISH ...**1.0246**
CONTAMINATION OF CHANNEL CATFISH WITH DIELDRIN FROM AGRICULTURAL RUNOFF ...**1.0247**
THE UPTAKE OF AND BIOLOGICAL RESPONSES TO AROCLORS IN CHANNEL CATFISH ...**1.0267**
THYROIDAL I125 UPTAKE IN IMMATURE CHANNEL CATFISH FOLLOWING EXPOSURE TO SELECTED TOXICANTS ...**1.0272**
COMPARISON OF METHODS USED TO MEASURE ESTERASE ACTIVITY. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...**1.0274**
EFFECTS OF PARATHION AND MALATHION ON WARMWATER FISH PONDS ...**1.0283**
UPTAKE, PERSISTENCE AND METABOLITES OF SEVIN BY CHANNEL CATFISH ...**1.0284**
CHRONIC TOXICITY OF PESTICIDES TO FISH ...**1.0287**
UPTAKE AND METABOLISM BY FISH OF 2,4-D DIMETHYL AMINE SALT ...**1.0293**
THE RELATIONSHIP BETWEEN THE USE OF AGRICULTURAL CHLORINATED HYDROCARBONS AND THEIR RESIDUES IN CHANNEL CATFISH ...**1.0298**
THE EFFECT OF DIELDRIN ON SURVIVAL AND DEVELOPMENT OF FISH EGGS ...**1.0300**
MERIDIAN STATE PARK LAKE CRAPPIE REMOVAL EXPERIMENT ...**2.0231**
THE EFFICACY OF QUINALDINE SULFATE - MS-222 AS AN ANESTHETIC FOR FISH IN THE LABORATORY - WARM SPRINGS ...**2.0239**
EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH ...**2.0260**
THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...**2.0261**
DETECTION OF CHANNEL CATFISH VIRUS (CCV) IN BROODSTOCK ...**3.0004**
METHOD OF CONTROLLING MORTALITY IN CHANNEL CATFISH DUE TO CCV INFECTION ...**3.0005**

EVALUATION OF THE INFLUENCE OF AGE AND SIZE OF CHANNEL CATFISH ON THE INFECTIVITY OF CCV ...3.0006

CHANNEL CATFISH VIRUS REPLICATION CURVES IN INTERNAL ORGANS AND ASSOCIATED PATHOLOGY ...3.0010

PATHOLOGY OF AEROMONAS LIQUIFACIENS IN CHANNEL CATFISH ...3.0013

INVESTIGATIONS OF AMEBIASIS IN FISH ...3.0014

COOPERATIVE FISH PARASITE AND DISEASE STUDY ...3.0015

PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...3.0108

CONTROL OF MYXOSPORIDIAN PARASITES ...3.0109

Lepisosteidae

DEVELOPMENTS OF METHODS RELATED TO TESTING OF FISH CONTROL AGENTS BIOCHEMICAL METHOD FOR SEXING FISH ...2.0248

Osmeridae

MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...3.0106

Osteichthyes -other

EFFECTS OF TOXICANTS UPON FISH MOVEMENT PATTERNS ...1.0308

SPAWNING AND REARING OF MARINE FISH ...3.0110

Percidae

Perca Flavescens

STREAM STUDIES TO DETERMINE TOXIC EFFECTS OF METHOXYCHLOR IN FISH POPULATIONS ...1.0263

LABORATORY BIOASSAYS TO DETERMINE TOXIC EFFECS OF METHOXYCHLOR IN FISH ...1.0264

STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0255

CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0259

Percidae -other

RELATIVE SUSCEPTIBILITIES OF FISH FAMILIES TO HERBICIDES ...1.0280

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0304

EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT) ...2.0229

SELECTIVE REMOVAL OF VARIOUS FISH SPECIES WITH ANTIMYCIN ...2.0240

SURVEYS FOR PANFISH CONTROL STUDIES ...4.0086

Stizostedion Canadense

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045

Stizostedion Vitreum Vitreum

THE EFFECT OF DIELDRIN ON SURVIVAL AND DEVELOPMENT OF FISH EGGS ...1.0300

EVALUATION OF POND CONDITIONS FOLLOWING FERTILIZATION ...2.0153

EXPERIMENTAL ESTABLISHMENT OF MONOSPECIFIC WALLEYE POPULATIONS AS A MANAGEMENT MEASURE FOR SMALL WARMWATER LAKES IN NORTHERN MINNESOTA ...2.0214

THE INTERACTION OF THE WALLEYE AND WHITE SUCKER IN THE FISH POPULATION OF SOFT WATER LAKE IN NORTHEASTERN MINNESOTA ...2.0215

EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP SOFTWATER LAKES ...2.0216

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045

WALLEYE AND NORTHERN PIKE STUDY ...3.0072

A STUDY OF THE INTERACTION OF THREE SPECIES OF BULLHEAD AND ASSOCIATED GAME FISH SPECIES IN A SINGLE LAKE ...4.0079

GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081

WALLEYE LIFE HISTORY STUDY ...4.0085

Pleuronectidae

THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...1.0253

PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES ...1.0254

EPIDERMAL PAPILLOMAS ...3.0021

MARINE FISHERIES - SYMBIOSIS AND PARASITISM - RESEARCH ...3.0055

Poeciliid

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...1.0249

SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA - CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...1.0268

THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0330

BIOLOGY AND CONTROL OF MOSQUITOES IN IRRIGATED AND WATER MANAGEMENT AREAS ...2.0011

BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES ...2.0014

EFFECT OF PREDATORS AND PARASITES ON MOSQUITO BREEDING IN LOUISIANA ...2.0045

Salmonidae

Oncorhynchus -other

INFECTIOUS DISEASES OF SALMONID FISHES ...3.0049

Oncorhynchus Gorbuscha

AQUICULTURE, SALMON CULTURE - RESEARCH ...3.0053

Oncorhynchus Keta

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0304

AQUICULTURE, SALMON CULTURE - RESEARCH ...3.0053

Oncorhynchus Kisutch

PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0163

RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...1.0256

QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...1.0259

BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH ...1.0261

MAGNITUDE AND NATURE OF POLYCHLORINATED BIPHENYLS IN COHO SALMON ...1.0262

PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES ...1.0306

FISHERY RESOURCES PROGRAM ...1.0317

PHARMACOLOGICAL AND ECOLOGICAL EFFECTS OF PESTICIDES ...1.0362

INVENTORY OF WATERS OF THE PROJECT AREA ...3.0039

EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...3.0089

ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - FURUNCULOSIS IN COHO SALMON ...3.0122

BIOCHEMICAL CHANGES IN FISH DISEASES - THE STRESS OF FORMALIN TREATMENTS IN SALMONID FISHES ...3.0124

EFFICACY OF A POTENTIATED SULFONAMIDE AGAINST FURUNCULOSIS INFECTIONS IN JUVENILE RAINBOW TROUT AND COHO SALMON ...3.0125

Oncorhynchus Nerka

SURVIVAL AND GROWTH OF KOKANEE AND COHO SALMON IN ANDERSON RANCH RESERVIOR ...2.0197

HISTOPATHOGENESIS OF KIDNEY DISEASE ...3.0091

HISTOPATHOLOGY OF SALMONID FISHES - HISTOPATHOGENESIS OF CULTUS LAKE VIRUS DISEASE ...3.0092

HISTOPATHOLOGY OF SALMONID FISHES: DIAGNOSIS ...3.0095

RELATIONSHIP OF TEMPERATURE TO DISEASES OF SALMONID FISH ...3.0116

Oncorhynchus Tshawytscha
- INVESTIGATION OF STRESS-INDUCED MOBILIZATION OF INSECTICIDE RESIDUES - CHRONIC TOXICITY OF PESTICIDES TO FISH ...**1.0281**
- AQUICULTURE, SALMON CULTURE - RESEARCH ...**3.0053**
- EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...**3.0119**

Prosopium
- FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES ...**4.0080**

Salmo -other
- EXPERIMENTAL RESTORATION OF THE GILA TROUT ...**2.0218**

Salmo Clarki
- SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0273**
- COMPARISON OF METHODS USED TO MEASURE ESTERASE ACTIVITY. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...**1.0274**
- METHOXYCHLOR-CAUSED EFFECTS ON CUTTHROAT TROUT PHYSIOLOGY - CHRONIC TOXICITY OF INSECTICIDES TO COLD-WATER FISH ...**1.0296**
- SQUAWFISH STUDIES--ST. JOE RIVER, IDAHO ...**2.0196**
- HISTOPATHOLOGY OF LAHONTAN CUTTHROAT TROUT ...**3.0080**
- THE TOXICITY AND DRUG RESIDUE LEVEL OF CHLORAMPHENICOL IN TREATED RAINBOW TROUT ...**3.0133**
- LIFE HISTORY OF ST. JOE RIVER CUTTHROAT TROUT ...**4.0077**
- FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES ...**4.0080**

Salmo Gairdneri
- PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0269**
- CHRONIC TOXICITY OF PESTICIDES TO FISH ...**1.0287**
- PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0288**
- UPTAKE AND METABOLISM BY FISH OF 2,4-D DIMETHYL AMINE SALT ...**1.0293**
- EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - ORGANOCHLORINE PESTICIDES AND DISEASE RESISTANCE MECHANISMS OF RAINBOW TROUT ...**1.0312**
- BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...**2.0006**
- EXPERIMENTAL INTRODUCTION OF EXOTIC FRESHWATER FISHES ...**2.0131**
- SQUAWFISH STUDIES--ST. JOE RIVER, IDAHO ...**2.0196**
- BIOASSAY ...**2.0211**
- RELATION OF LAMPREY EELS TO EXISTING SALMONID STOCKS IN CAYUGA LAKE ...**2.0219**
- PLANNING FOR CREATION OF SALMONID FISHERIES IN LAKE ONTARIO ...**2.0221**
- PRE-LAMPREY CONTROL INVENTORY OF FISH STOCKS ...**2.0222**
- EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...**2.0234**
- ROUTE(S) OF EXCRETION OF QUINALDINE SULFATE, A FISH ANESTHETIC ...**2.0249**
- IN VIVO AND IN VITRO STUDIES ON THE MODE OF ACTION OF TFM ...**2.0250**
- METABOLISM AND EXCRETION OF TFM ...**2.0251**
- THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...**2.0252**
- THE EFFECTS OF THANITE ON THE ACID-BASE BALANCE IN THE BLOOD OF FISHES ...**2.0254**
- STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...**2.0255**
- CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...**2.0259**
- EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH ...**2.0260**
- THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...**2.0261**
- THE EFFECTS OF ANTIMYCIN A ON THE METABOLISM OF SELECTED TISSUES IN FISH (ABBREV) ...**2.0262**
- COOPERATIVE FISH DISEASE PROJECT ...**3.0009**
- REFINEMENT OF MANAGEMENT TECHNIQUES FOR STREAM TROUT LAKES ...**3.0035**
- EXPERIMENTAL CONTROL OF NEASCUS IN SMALL TROUT LAKES ...**3.0036**
- MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...**3.0056**
- IMPROVEMENT OF SALMON AND STEELHEAD TROUT HATCHERY TECHNIQUES ...**3.0059**
- THE EFFECTS OF DIFFERENTLY EXTRACTED ENDOTOXINS FROM ESCHERICHIA COLI ON RAINBOW TROUT (SALMO GAIRDNERI) ...**3.0071**
- HISTOPATHOLOGY OF LIVERS OF RAINBOW TROUT FED RANCID PELLETS CONTAINING AFLATOXIN ...**3.0081**
- ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - RED MOUTH COMPARATIVE VACCINE STUDY ...**3.0085**
- EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...**3.0089**
- HISTOPATHOLOGY OF SALMONID FISHES - BACTERIAL RED-MOUTH DISEASE HISTOPATHOGENESIS OF RAINBOW TROUT (SALMON GAIRDNERI) ...**3.0093**
- HISTOPATHOLOGY OF SALMONID FISHES: DIAGNOSIS ...**3.0095**
- LONGEVITY OF SPORES OF 'MYOXOSOMA CEREBRALIS' (WHIRLING DISEASE) ...**3.0102**
- VERTEBRATE DISEASES - VIRAL DISEASES OF FRESHWATER FISHES AND OTHER LOWER VERTEBRATES EGTVED VIRUS ...**3.0104**
- POSSIBLE BIRD TRANSMISSION OF 'MYXOSOMA CEREBRALIS' ...**3.0105**
- EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...**3.0119**
- BIOCHEMICAL CHANGES IN FISH DISEASES - THE STRESS OF FORMALIN TREATMENTS IN SALMONID FISHES ...**3.0124**
- EFFICACY OF A POTENTIATED SULFONAMIDE AGAINST FURUNCULOSIS INFECTIONS IN JUVENILE RAINBOW TROUT AND COHO SALMON ...**3.0125**
- THE TOXICITY AND DRUG RESIDUE LEVEL OF CHLORAMPHENICOL IN TREATED RAINBOW TROUT ...**3.0133**

Salmo Salar
- EFFECTS OF CHRONIC SUBLETHAL DOSAGES OF DDT ON THE SWIMMING PERFORMANCE OF ATLANTIC SALMON PARR ...**1.0252**
- PLANNING FOR CREATION OF SALMONID FISHERIES IN LAKE ONTARIO ...**2.0221**

Salmo Trutta
- IN VIVO AND IN VITRO STUDIES ON THE MODE OF ACTION OF TFM ...**2.0250**
- THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...**2.0252**
- THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...**2.0261**
- RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT FINGERLINGS TO FURUNCULOSIS ...**3.0041**
- RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT YEARLINGS TO FURUNCULOSIS ...**3.0042**
- FIELD TESTING OF SELECTIVELY BRED STRAINS OF BROOK AND BROWN TROUT UNDER PRODUCTION HATCHERY CONDITIONS ...**3.0043**
- THE TOXICITY AND DRUG RESIDUE LEVEL OF CHLORAMPHENICOL IN TREATED RAINBOW TROUT ...**3.0133**

Salmon -nonspecific
- THE RELATIONSHIP OF TEMPERATURE TO DISEASE OF SALMONID FISHES ...**3.0051**
- IMPROVEMENT OF SALMON AND STEELHEAD TROUT HATCHERY TECHNIQUES ...**3.0059**

EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS .. 3.0083
CONTROL OF VIBRIOSIS IN SALMON ...3.0117
EVALUATION OF STRESS IN FINGERLING SALMON THERAPEUTIC DRUGS AS STRESS FACTORS ...3.0120
AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...3.0126

Salmonids -nonspecific
THE SUSCEPTIBILITY OF VARIOUS LIFE STAGES OF FRESHWATER FISHES TO THREE TOXICANTS ...1.0279
RELATIVE SUSCEPTIBILITIES OF FISH FAMILIES TO HERBICIDES ...1.0280
TRIBUTARY SURVEY OF LAKES ONTARIO AND ERIE ...2.0220
EPIDEMOLOGY OF 'SALMON POISONING' DISEASE ...3.0054
IMPACT OF CERATOMYXA IN CENTRAL OREGON SALMONID POPULATIONS ...3.0057
USE OF CELL CULTURE METHODS TO ATTEMPT TO FOLLOW DEVELOPING STAGES OF SPORES ...3.0062
UTILIZATION OF INVERTEBRATE VECTORS IN THE TRANSMISSION OF WHIRLING DISEASE ...3.0064
TREATMENT OF WHIRLING DISEASE SPORES TO PRODUCE INFECTIVE STATES OF THE ORGANISM ...3.0066
METHODS OF COLLECTING AND CONCENTRATING SPORES TAKEN FROM INFECTED FISH ...3.0067
NEOPLASMS OF SALMONID FISHES ...3.0094
INFECTIOUS DISEASES OF SOME SALMONID FISHES AND THE ASSOCIATED HISTOPATHOLOGY ...3.0099

Salvelinus Fontinalis
IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS ...1.0335
STUDY OF CHRONIC TOXICITY OF LINDANE TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0337
STUDY OF CHRONIC TOXICITY OF PARATHION TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0357
JO-MARY POND RECLAMATION ...2.0201
THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...2.0261
REFINEMENT OF MANAGEMENT TECHNIQUES FOR STREAM TROUT LAKES ...3.0035
RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT FINGERLINGS TO FURUNCULOSIS ...3.0041
RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT YEARLINGS TO FURUNCULOSIS ...3.0042
FIELD TESTING OF SELECTIVELY BRED STRAINS OF BROOK AND BROWN TROUT UNDER PRODUCTION HATCHERY CONDITIONS ...3.0043
BIOCHEMICAL CHANGES IN FISH DISEASES - THE STRESS OF FORMALIN TREATMENTS IN SALMONID FISHES ...3.0124
THE TOXICITY AND DRUG RESIDUE LEVEL OF CHLORAMPHENICOL IN TREATED RAINBOW TROUT ...3.0133
RENOVATION OF TROUT STREAMS ...4.0076

Salvelinus Namaycush
RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...1.0256
MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...1.0266
CHRONIC TOXICITY OF PESTICIDES TO COLD-WATER FISH ...1.0318
ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202
SEA LAMPREY CONTROL - LAKE MICHIGAN CHEMICAL CONTROL ...2.0203
SEA LAMPREY CONTROL - LAKE HURON CHEMICAL CONTROL ...2.0204
LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...2.0205
LAKE HURON CHEMICAL CONTROL ...2.0209
LAKE SUPERIOR COMMERCIAL FISHERIES ASSESSMENT STUDIES ...2.0212
EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP SOFTWATER LAKES ...2.0216
RELATION OF LAMPREY EELS TO EXISTING SALMONID STOCKS IN CAYUGA LAKE ...2.0219
EVALUATE FISH TOXICANT (ANTIMYCIN) (EAGLE LAKE SEGMENT) ...2.0230
POPULATION DYNAMICS - LAKE TROUT ...2.0235
THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...2.0261
ASSESSMENT OF LAKE TROUT AND ASSOCIATED SPECIES IN LAKES MICHIGAN AND SUPERIOR ...2.0264

Trout -nonspecific
PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260
NERVE IMPULSE TRANSMISSION CHARACTERISTICS OF ISOLATED FISH-NERVE PREPARATIONS PERFUSED WITH PHYSIOLOGICAL LEVELS OF SELECTED PESTICIDES ...1.0271
ELIMINATE OR REDUCE EFFECTS OF PESTICIDE RESIDUES ...1.0311
SUBLETHAL AMOUNTS OF ORGANIC INSECTICIDES AND FISH ...1.0313
EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP, SOFT-WATER LAKES ...2.0213
TIME-CONCENTRATION TESTS INVOLVING NEUTRALIZATION OF ROTENONE WITH POTASSIUM PERMANGANATE ...2.0224
EXPERIMENTAL RECLAMATION OF TROUT STREAMS THROUGH CHEMICAL TREATMENT ...2.0263
CHARACTERIZATION OF THE INFECTIOUS PANCREATIC NECROSIS (IPN) VIRUS OF TROUT ...3.0031
CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045
SUSCEPTIBILITY OF VARIOUS AGES OF FISH TO INFECTION ...3.0063
USE OF TISSUE SECTIONING TECHNIQUES TO ATTEMPT TO FOLLOW THE LIFE HISTORY OF WHIRLING DISEASE PARASITES FROM THE FIRST DAY OF INFECTION ...3.0065
DETERMINE IF SPORES OR INFECTIVE STAGES ARE SHED FROM LIVING FISH ...3.0068
DETECTION OF CARRIER CONDITION IN FURUNCULOSIS ...3.0098
AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...3.0126
CONTROL OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA FILTRATION AND ULTRAVIOLET IRRADIATION ...3.0129

Sciaenidae
SALT WATER POND RESEARCH ...3.0073
A HISTOPATHOLOGICAL STUDY AND DESCRIPTION OF ACUTE INFLAMMATORY RESPONSE IN SPECKLED TROUT (CYNOSCION NEBULOSUS) ...3.0075

Scorpaenidae
MARINE FISHERIES - SYMBIOSIS AND PARASITISM - RESEARCH ...3.0055

Serranidae
Roccus Spp.
TOXICITY OF POLLUTANTS TO STRIPED BASS ...1.0251
STRIPED BASS STUDIES ...2.0193
EFFECTS OF METHOXYCHLOR ON THE CONDITIONING OF STRIPED BASS TO AN OLFACTORY STIMULUS ...2.0233
SURVEY OF ANIMAL DISEASES IN CONNECTICUT ...3.0024
BACTERIAL FLORA OF APPARENTLY HEALTHY STRIPED BASS (ROCCUS SAXATILIS) & ITS CORRELATION WITH THE BACTERIA OF THE HATCHERY WATER SUPPLY ...3.0046
ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...3.0052
INVESTIGATION OF HANDLING TECHNIQUES ...3.0111
TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS ...3.0112
GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081

Fish & Shellfish Biology

Captive Rearing

Aquaria

- EFFECT OF DISINFECTING AGENTS ON M. CEREBRALIS ...3.0130
- TRANSMISSION OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA ...3.0132

Captive Rearing -general

- PESTICIDE MONITORING ...1.0217
- ELIMINATE OR REDUCE EFFECTS OF PESTICIDE RESIDUES ...1.0311
- DETERMINATION OF DIGESTION RATES FOR TROUT ...1.0346
- AQUATIC WEED CONTROL BY POND FISHES ...2.0139
- MARINE FISHERIES - SYMBIOSIS AND PARASITISM - RESEARCH ...3.0055
- SALT WATER POND RESEARCH ...3.0073
- SPAWNING AND REARING OF MARINE FISH ...3.0110
- CONTROL OF VIBRIOSIS IN SALMON ...3.0117
- EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...3.0119

Fish Hatcheries

- EXPERIMENTAL INTRODUCTION OF EXOTIC FRESHWATER FISHES ...2.0131
- JO-MARY POND RECLAMATION ...2.0201
- COOPERATIVE FISH DISEASE PROJECT ...3.0012
- REFINEMENT OF MANAGEMENT TECHNIQUES FOR STREAM TROUT LAKES ...3.0035
- FIELD TESTING OF SELECTIVELY BRED STRAINS OF BROOK AND BROWN TROUT UNDER PRODUCTION HATCHERY CONDITIONS ...3.0043
- AQUICULTURE, SALMON CULTURE - RESEARCH ...3.0053
- MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...3.0056
- IMPROVEMENT OF SALMON AND STEELHEAD TROUT HATCHERY TECHNIQUES ...3.0059
- SUSCEPTIBILITY OF VARIOUS AGES OF FISH TO INFECTION ...3.0063
- ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - RED MOUTH COMPARATIVE VACCINE STUDY ...3.0085
- AQUICULTURE, OYSTER HATCHERIES - RESEARCH ...3.0118
- ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - FURUNCULOSIS IN COHO SALMON ...3.0122
- REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES ...4.0083

Censusing

- STRIPED BASS STUDIES ...2.0193
- SURVIVAL AND GROWTH OF KOKANEE AND COHO SALMON IN ANDERSON RANCH RESERVIOR ...2.0197
- BIOLOGICAL AND LIMNOLOGICAL INVENTORY OF SEVEN FLOOD CONTROL RESERVOIRS IN THE STATE OF INDIANA ...2.0199
- STUDY OF THE SEA LAMPREY IN LOVE LAKE ...2.0200
- SEA LAMPREY CONTROL - ASSESSMENT METHODS ...2.0208
- MERIDIAN STATE PARK LAKE CRAPPIE REMOVAL EXPERIMENT ...2.0231
- INVENTORY OF WATERS OF THE PROJECT AREA ...3.0039

Commercial Fishing

- EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133
- PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...1.0236
- ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202
- SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...2.0206
- LAKE SUPERIOR COMMERCIAL FISHERIES ASSESSMENT STUDIES ...2.0212
- PLANNING FOR CREATION OF SALMONID FISHERIES IN LAKE ONTARIO ...2.0221
- POPULATION DYNAMICS - LAKE TROUT ...2.0235
- ASSESSMENT OF LAKE TROUT AND ASSOCIATED SPECIES IN LAKES MICHIGAN AND SUPERIOR ...2.0264
- OYSTER DRIL (OCINEBRA JAPONICA) CONTROL ...2.0293
- OYSTER DISEASE MORTALITY ALONG THE CALIFORNIA COAST ...3.0022
- AQUICULTURE, SALMON CULTURE - RESEARCH ...3.0053
- MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...3.0060
- MARINE FISH-CULTURE PATHOLOGY ...3.0070
- TESTS OF SELECTED SEED OYSTER STOCKS ON COMMERCIAL BEDS ...3.0079
- MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082
- AQUICULTURE, OYSTER HATCHERIES - RESEARCH ...3.0118
- LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN ...4.0082

Control of Nuisance Species

- DEVELOPMENT OF ON-SITE BIOASSAY METHODS ...1.0108
- EVALUATION OF GIZZARD SHAD AS A FORAGE FISH ...1.0356
- CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101
- EXPERIMENTAL USE OF PESTICIDES FOR FISHERIES MANAGEMENT PURPOSES ...2.0189
- SMALL IMPOUNDMENT STOCKING ...2.0190
- STUDIES OF SHARK REPELLENTS AND OTHER ANTISHARK MEASURES ...2.0191
- HAUL SEINE STUDY ...2.0192
- STRIPED BASS STUDIES ...2.0193
- RESTORING 'BALANCE' WITH ROTENONE AND FINTROL ...2.0194
- SQUAWFISH CONTROL IN CASCADE RESERVOIR ...2.0195
- SURVIVAL AND GROWTH OF KOKANEE AND COHO SALMON IN ANDERSON RANCH RESERVIOR ...2.0197
- BIOLOGICAL AND LIMNOLOGICAL INVENTORY OF SEVEN FLOOD CONTROL RESERVOIRS IN THE STATE OF INDIANA ...2.0199
- STUDY OF THE SEA LAMPREY IN LOVE LAKE ...2.0200
- JO-MARY POND RECLAMATION ...2.0201
- ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202
- SEA LAMPREY CONTROL - LAKE MICHIGAN CHEMICAL CONTROL ...2.0203
- SEA LAMPREY CONTROL - LAKE HURON CHEMICAL CONTROL ...2.0204
- LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...2.0205
- SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...2.0206
- SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...2.0207
- SEA LAMPREY CONTROL - ASSESSMENT METHODS ...2.0208
- LAKE HURON CHEMICAL CONTROL ...2.0209
- BIOLOGY OF THE LARVAL SEA LAMPREY ...2.0210
- BIOASSAY ...2.0211
- LAKE SUPERIOR COMMERCIAL FISHERIES ASSESSMENT STUDIES ...2.0212
- EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP, SOFT-WATER LAKES ...2.0213
- EXPERIMENTAL ESTABLISHMENT OF MONOSPECIFIC WALLEYE POPULATIONS AS A MANAGEMENT MEASURE FOR SMALL WARMWATER LAKES IN NORTHERN MINNESOTA ...2.0214
- THE INTERACTION OF THE WALLEYE AND WHITE SUCKER IN THE FISH POPULATION OF SOFT WATER LAKE IN NORTHEASTERN MINNESOTA ...2.0215
- EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP SOFTWATER LAKES ...2.0216
- THE USE OF PHEROMONES BY CARP, CYPRINUS CARPIO-RESEARCH ...2.0217
- EXPERIMENTAL RESTORATION OF THE GILA TROUT ...2.0218
- RELATION OF LAMPREY EELS TO EXISTING SALMONID STOCKS IN CAYUGA LAKE ...2.0219

TRIBUTARY SURVEY OF LAKES ONTARIO AND ERIE ...2.0220
PLANNING FOR CREATION OF SALMONID FISHERIES IN LAKE ONTARIO ...2.0221
PRE-LAMPREY CONTROL INVENTORY OF FISH STOCKS ...2.0222
DEVELOPMENT OF ACCURATE CHEMICAL INTRODUCTION TECHNIQUES ...2.0223
TIME-CONCENTRATION TESTS INVOLVING NEUTRALIZATION OF ROTENONE WITH POTASSIUM PERMANGANATE ...2.0224
AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO ...2.0227
PISCICIDE TOXICOLOGY OF THE CYPRINIDS IN EAST AND WEST PAULINA LAKES ...2.0228
EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT) ...2.0229
EVALUATE FISH TOXICANT (ANTIMYCIN) (EAGLE LAKE SEGMENT) ...2.0230
MERIDIAN STATE PARK LAKE CRAPPIE REMOVAL EXPERIMENT ...2.0231
FISH TOXICANT STUDIES ...2.0232
POPULATION DYNAMICS - LAKE TROUT ...2.0235
RESIDUES OF MS-222 IN FISH ...2.0236
THE DEVELOPMENT OF ANALYTICAL METHODS CAPABLE OF MEASURING TFM RESIDUES IN FISH, WATER, AND OTHER COMPLEX SUBSTRATES ...2.0238
INTENSIVE SCREENING OF POTENTIAL FISH CONTROL AGENTS - POTENTIATION OF ANTIMYCIN ...2.0241
THE EFFICACY OF THANITE (ISOBORNYL THIOCYANOACETATE) AS A FISH COLLECTION AID ...2.0242
THE EFFICACY OF MONSANTO NO. 51294 AS A FISH TOXICANT (LABORATORY) ...2.0243
THE EFFICACY AND PERSISTENCE OF FORMULATIONS OF ANTIMYCIN ...2.0244
DEVELOPMENT OF RHODAMINE-B DYE TO TRACE FLOW AND DISPERSION PATTERNS IN STREAMS AS AN ADJUNCT TO TREATING STREAMS WITH FISH-CONTROL CHEMICALS ...2.0245
ESTABLISH MINIMUM DOSES OF ANTIMYCIN AND ROTENONE NEEDED FOR TOTAL KILLS OF TARGET FISHES ...2.0247
DEVELOPMENTS OF METHODS RELATED TO TESTING OF FISH CONTROL AGENTS BIOCHEMICAL METHOD FOR SEXING FISH ...2.0248
THE EFFECTS OF THANITE ON THE ACID-BASE BALANCE IN THE BLOOD OF FISHES ...2.0254
STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0255
STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES ...2.0256
STATIC BIOASSAY OF COLLECTING AIDS AGAINST FISH ...2.0257
STATIC BIOASSAY OF ATTRACTANTS AND REPELLANTS AGAINST FISH AND INVERTEBRATES ...2.0258
CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0259
THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...2.0261
THE EFFECTS OF ANTIMYCIN A ON THE METABOLISM OF SELECTED TISSUES IN FISH (ABBREV) ...2.0262
EXPERIMENTAL RECLAMATION OF TROUT STREAMS THROUGH CHEMICAL TREATMENT ...2.0263
ASSESSMENT OF LAKE TROUT AND ASSOCIATED SPECIES IN LAKES MICHIGAN AND SUPERIOR ...2.0264
NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...2.0271
EXPERIMENTS TO RE-ESTABLISH HISTORICAL OYSTER SEED GROUNDS AND TO CONTROL THE SOUTHERN OYSTER DRILL ...2.0274
EFFECTS OF WATER EXCHANGE AND BLUE CRAB CONTROL ON SHRIMP PRODUCTION IN LOUISIANA SALTMARSH IMPOUNDMENTS ...2.0275
OYSTER DRIL (OCINEBRA JAPONICA) CONTROL ...2.0293
REFINEMENT OF MANAGEMENT TECHNIQUES FOR STREAM TROUT LAKES ...3.0035
INVENTORY OF WATERS OF THE PROJECT AREA ...3.0039
INVESTIGATION OF HANDLING TECHNIQUES ...3.0111
AQUICULTURE, OYSTER HATCHERIES - RESEARCH ...3.0118
EFFECT OF DISINFECTING AGENTS ON M. CEREBRALIS ...3.0130
LIFE HISTORY OF ST. JOE RIVER CUTTHROAT TROUT ...4.0077
A STUDY OF THE INTERACTION OF THREE SPECIES OF BULLHEAD AND ASSOCIATED GAME FISH SPECIES IN A SINGLE LAKE ...4.0079
GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081
SURVEYS FOR PANFISH CONTROL STUDIES ...4.0086

Drugs

THE TOXICITY AND DETOXIFICATION OF THE ROTENONE FORMULATIONS USED IN FISH MANAGEMENT ...2.0226
INVESTIGATION OF HANDLING TECHNIQUES ...3.0111
TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS ...3.0112

Dyes

STATIC BIOASSAY OF TRACERS AND DYES AGAINST FISH AND INVERTEBRATES ...1.0316

Electro-fishing

SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...2.0207
PRE-LAMPREY CONTROL INVENTORY OF FISH STOCKS ...2.0222
INVESTIGATION OF HANDLING TECHNIQUES ...3.0111

Endangered Species

EXPERIMENTAL RESTORATION OF THE GILA TROUT ...2.0218

Fertilizers -aquatic

FARM FISH POND MANAGEMENT ...1.0340
DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...2.0094
FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...2.0142
EVALUATION OF POND CONDITIONS FOLLOWING FERTILIZATION ...2.0153

Fishery Development -other

A STUDY OF THE INTERACTION OF THREE SPECIES OF BULLHEAD AND ASSOCIATED GAME FISH SPECIES IN A SINGLE LAKE ...4.0079
LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN ...4.0082

Food Supply

METABOLISM OF ENDRIN IN PONDS ...1.0113
PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...1.0236
ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...1.0326
STUDY OF CHRONIC TOXICITY OF LINDANE TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0337
FARM FISH POND MANAGEMENT ...1.0340
DETERMINATION OF DIGESTION RATES FOR TROUT ...1.0346
EVALUATION OF GIZZARD SHAD AS A FORAGE FISH ...1.0356
AQUATIC WEED CONTROL BY POND FISHES ...2.0139
EVALUATION OF POND CONDITIONS FOLLOWING FERTILIZATION ...2.0153
BIOLOGY OF THE LARVAL SEA LAMPREY ...2.0210
EXPERIMENTAL ESTABLISHMENT OF MONOSPECIFIC WALLEYE POPULATIONS AS A MANAGEMENT MEASURE FOR SMALL WARMWATER LAKES IN NORTHERN MINNESOTA ...2.0214
PLANNING FOR CREATION OF SALMONID FISHERIES IN LAKE ONTARIO ...2.0221
POPULATION DYNAMICS - LAKE TROUT ...2.0235
EXPERIMENTAL RECLAMATION OF TROUT STREAMS THROUGH CHEMICAL TREATMENT ...2.0263

LIMNOLOGICAL, ICHTHYOLOGICAL, AND PARASITOLOGICAL INVESTIGATIONS ON ARKANSAS RESERVOIRS IN RELATION TO WATER QUALITY ...3.0019
ENVIRONMENTAL STUDY ...3.0030
ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...3.0052
MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...3.0056
WALLEYE AND NORTHERN PIKE STUDY ...3.0072
SALT WATER POND RESEARCH ...3.0073
NUTRITIONAL FACTORS IN THE DEVELOPMENT OF CORYNEBACTERIAL KIDNEY DISEASE ...3.0090
FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES ...4.0080

Legislation

LAKE SUPERIOR COMMERCIAL FISHERIES ASSESSMENT STUDIES ...2.0212

Management -other

STATIC BIOASSAY OF TRACERS AND DYES AGAINST FISH AND INVERTEBRATES ...1.0316
ECOLOGICAL STUDIES OF WILDLIFE MANAGEMENT PRACTICES ...1.0327
THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...2.0261
EPIZOOTIOLOGY OF PARASITIC DISEASES IN FISH POPULATIONS UNDER INTENSIVE MANAGEMENT ...3.0001
ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...3.0052
LIFE HISTORY OF ST. JOE RIVER CUTTHROAT TROUT ...4.0077
FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES ...4.0080
LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN ...4.0082

Mark, Tag or Capture -other

FISHERIES UNIT ...1.0203
ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...3.0052
EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...3.0119

Nets

DETERMINATION OF DIGESTION RATES FOR TROUT ...1.0346
HAUL SEINE STUDY ...2.0192
SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...2.0207
PRE-LAMPREY CONTROL INVENTORY OF FISH STOCKS ...2.0222
MERIDIAN STATE PARK LAKE CRAPPIE REMOVAL EXPERIMENT ...2.0231
ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...3.0052
WALLEYE AND NORTHERN PIKE STUDY ...3.0072
INVESTIGATION OF HANDLING TECHNIQUES ...3.0111

Pathology

ENZYME AND TISSUE ALTERATIONS IN FISH - A MEASURE OF WATER QUALITY ...1.0248
SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA - CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...1.0268
EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - ORGANOCHLORINE PESTICIDES AND DISEASE RESISTANCE MECHANISMS OF RAINBOW TROUT ...1.0312
STATIC BIOASSAY OF TRACERS AND DYES AGAINST FISH AND INVERTEBRATES ...1.0316
FISHERY RESOURCES PROGRAM ...1.0317
CHRONIC TOXICITY OF PESTICIDES TO COLD-WATER FISH ...1.0318
ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202
EPIZOOTIOLOGY OF PARASITIC DISEASES IN FISH POPULATIONS UNDER INTENSIVE MANAGEMENT ...3.0001
IDENTIFICATION OF PARASITIC BACTERIAL FORMS ...3.0002
INVESTIGATE CONTROL MEASURES OF BACTERIAL INFECTIONS IN FISH ...3.0003
DETECTION OF CHANNEL CATFISH VIRUS (CCV) IN BROODSTOCK ...3.0004
METHOD OF CONTROLLING MORTALITY IN CHANNEL CATFISH DUE TO CCV INFECTION ...3.0005
EVALUATION OF THE INFLUENCE OF AGE AND SIZE OF CHANNEL CATFISH ON THE INFECTIVITY OF CCV ...3.0006
SUSCEPTIBILITY OF OTHER SPECIES OF CATFISHES TO CCV AND THEIR POSSIBLE ROLE AS CARRIERS ...3.0007
DEVELOPMENT OF NEW FISH CELL LINES ...3.0008
COOPERATIVE FISH DISEASE PROJECT ...3.0009
CHANNEL CATFISH VIRUS REPLICATION CURVES IN INTERNAL ORGANS AND ASSOCIATED PATHOLOGY ...3.0010
DISTRIBUTION OF THE GENUS ERGASILUS (PARASITIC COPEPOD) IN THE SOUTHEASTERN UNITED STATES ...3.0011
COOPERATIVE FISH DISEASE PROJECT ...3.0012
PATHOLOGY OF AEROMONAS LIQUIFACIENS IN CHANNEL CATFISH ...3.0013
INVESTIGATIONS OF AMEBIASIS IN FISH ...3.0014
COOPERATIVE FISH PARASITE AND DISEASE STUDY ...3.0015
PUBLICATION OF FISH BACTERIAL RESEARCH ...3.0016
PUBLICATION OF FISH VIRUS RESEARCH ...3.0017
IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...3.0018
LIMNOLOGICAL, ICHTHYOLOGICAL, AND PARASITOLOGICAL INVESTIGATIONS ON ARKANSAS RESERVOIRS IN RELATION TO WATER QUALITY ...3.0019
STUDY OF THE INCIDENCE AND LIFE CYCLES OF MYXOSPORIDIAL INFECTIONS IN WARM WATER FISHES (REVISED) ...3.0020
EPIDERMAL PAPILLOMAS ...3.0021
OYSTER DISEASE MORTALITY ALONG THE CALIFORNIA COAST ...3.0022
EPIZOOTIOLOGY OF LEPTOSPIRES - FISH SUSCEPTIBILITY TO L. ICTEROHAEMORRHIGICA (ABBREV) ...3.0023
SURVEY OF ANIMAL DISEASES IN CONNECTICUT ...3.0024
DISEASES OF FISH ...3.0025
VIBRIO PARAHAEMOLYTICUS IN CHESAPEAKE BAY - ISOLATION, INCIDENCE AND PATHOGENICITY ...3.0026
PATHOLOGY RESEARCH ...3.0027
UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029
ENVIRONMENTAL STUDY ...3.0030
CHARACTERIZATION OF THE INFECTIOUS PANCREATIC NECROSIS (IPN) VIRUS OF TROUT ...3.0031
MOLLUSCAN MORTALITY STUDIES ...3.0032
SHELLFISH MORTALITY - CHESAPEAKE BAY ...3.0033
PACIFIC OYSTER MORTALITY STUDIES ...3.0034
EXPERIMENTAL CONTROL OF NEASCUS IN SMALL TROUT LAKES ...3.0036
IDENTIFICATION OF PARASITES AND DISEASES EFFECTING MARICULTURE SPECIES ...3.0037
TRANSMISSION OF AN OVARY PARASITE OF THE GOLDEN SHINER ...3.0038
ETIOLOGY OF ESTUARINE FISH DISEASES ...3.0040
RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT FINGERLINGS TO FURUNCULOSIS ...3.0041
RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT YEARLINGS TO FURUNCULOSIS ...3.0042
FIELD TESTING OF SELECTIVELY BRED STRAINS OF BROOK AND BROWN TROUT UNDER PRODUCTION HATCHERY CONDITIONS ...3.0043
ANALYSIS OF DATA AND PREPARATION OF MANUSCRIPTS FOR PUBLICATION ...3.0044
CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045
BACTERIAL FLORA OF APPARENTLY HEALTHY STRIPED BASS (ROCCUS SAXATILIS) & ITS CORRELATION WITH

THE BACTERIA OF THE HATCHERY WATER SUPPLY ...3.0046
PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...3.0047
RESEARCH VESSEL OPERATIONS ...3.0048
INFECTIOUS DISEASES OF SALMONID FISHES ...3.0049
BIOLOGY OF THE PROTOZOAN PARASITE CERATOMYXA SHASTA ...3.0050
THE RELATIONSHIP OF TEMPERATURE TO DISEASE OF SALMONID FISHES ...3.0051
ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...3.0052
AQUICULTURE, SALMON CULTURE - RESEARCH ...3.0053
EPIDEMOLOGY OF 'SALMON POISONING' DISEASE ...3.0054
MARINE FISHERIES - SYMBIOSIS AND PARASITISM - RESEARCH ...3.0055
MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...3.0056
IMPACT OF CERATOMYXA IN CENTRAL OREGON SALMONID POPULATIONS ...3.0057
TRANSMISSION OF CERATOMYXA SHASTA ...3.0058
IMPROVEMENT OF SALMON AND STEELHEAD TROUT HATCHERY TECHNIQUES ...3.0059
MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...3.0060
VIRAL DISEASES OF MARINE FISHES ...3.0061
USE OF CELL CULTURE METHODS TO ATTEMPT TO FOLLOW DEVELOPING STAGES OF SPORES ...3.0062
SUSCEPTIBILITY OF VARIOUS AGES OF FISH TO INFECTION ...3.0063
UTILIZATION OF INVERTEBRATE VECTORS IN THE TRANSMISSION OF WHIRLING DISEASE ...3.0064
USE OF TISSUE SECTIONING TECHNIQUES TO ATTEMPT TO FOLLOW THE LIFE HISTORY OF WHIRLING DISEASE PARASITES FROM THE FIRST DAY OF INFECTION ...3.0065
TREATMENT OF WHIRLING DISEASE SPORES TO PRODUCE INFECTIVE STATES OF THE ORGANISM ...3.0066
METHODS OF COLLECTING AND CONCENTRATING SPORES TAKEN FROM INFECTED FISH ...3.0067
DETERMINE IF SPORES OR INFECTIVE STAGES ARE SHED FROM LIVING FISH ...3.0068
MULTIPLICATION OF ENTERIC VIRUSES IN SHELLFISH ...3.0069
MARINE FISH-CULTURE PATHOLOGY ...3.0070
THE EFFECTS OF DIFFERENTLY EXTRACTED ENDOTOXINS FROM ESCHERICHIA COLI ON RAINBOW TROUT (SALMO GAIRDNERI) ...3.0071
WALLEYE AND NORTHERN PIKE STUDY ...3.0072
SALT WATER POND RESEARCH ...3.0073
BACTERIAL AND VIRAL DISEASES AND CELL CULTURES OF MARINE FISH AND SHELLFISH ...3.0074
A HISTOPATHOLOGICAL STUDY AND DESCRIPTION OF ACUTE INFLAMMATORY RESPONSE IN SPECKLED TROUT (CYNOSCION NEBULOSUS) ...3.0075
A HISTOLOGIC STUDY OF MARINE FISH ...3.0076
TESTING OF STOCKS OF OYSTERS FOR DISEASE RESISTANCE ...3.0077
ACQUIRED VS. GENETIC RESISTANCE IN OYSTERS ...3.0078
TESTS OF SELECTED SEED OYSTER STOCKS ON COMMERCIAL BEDS ...3.0079
HISTOPATHOLOGY OF LAHONTAN CUTTHROAT TROUT ...3.0080
HISTOPATHOLOGY OF LIVERS OF RAINBOW TROUT FED RANCID PELLETS CONTAINING AFLATOXIN ...3.0081
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082
EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...3.0083
ISOLATION OF VIRUSES FROM FISHES - INVESTIGATION OF FISH EPIZOOTICS OF UNKNOWN ETIOLOGY FOR POSSIBLE VIRUS INVOLVEMENT ...3.0084
ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - RED MOUTH COMPARATIVE VACCINE STUDY ...3.0085
CYTOPATHOGENIC EFFECT OF TOXIN ON TISSUE ...3.0086
CYTOPATHOGENIC EFFECT OF TOXIN IN FISH ...3.0087
CORRELATE NITROGEN GAS CONTENT OF WATER SUPPLIES WITH DISEASE ...3.0088
EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...3.0089
NUTRITIONAL FACTORS IN THE DEVELOPMENT OF CORYNEBACTERIAL KIDNEY DISEASE ...3.0090
HISTOPATHOGENESIS OF KIDNEY DISEASE ...3.0091
HISTOPATHOLOGY OF SALMONID FISHES - HISTOPATHOGENESIS OF CULTUS LAKE VIRUS DISEASE ...3.0092
HISTOPATHOLOGY OF SALMONID FISHES - BACTERIAL RED-MOUTH DISEASE HISTOPATHOGENESIS OF RAINBOW TROUT (SALMON GAIRDNERI) ...3.0093
NEOPLASMS OF SALMONID FISHES ...3.0094
HISTOPATHOLOGY OF SALMONID FISHES: DIAGNOSIS ...3.0095
BACTERIOLOGICAL AND SEROLOGICAL STUDIES ON MOTILE AEROMONADS AND PSEUDOMONADS FRESHLY ISOLATED FROM DISEASED FISHES ...3.0096
DEVELOPMENT OF METHODS FOR RAPID IDENTIFICATION OF BACTERIAL FISH PATHOGENS ...3.0097
DETECTION OF CARRIER CONDITION IN FURUNCULOSIS ...3.0098
INFECTIOUS DISEASES OF SOME SALMONID FISHES AND THE ASSOCIATED HISTOPATHOLOGY ...3.0099
PARASITOLOGY - PARASITES AND PARASITIC DISEASES OF FISHES - IMMUNIZATION STUDY FOR ICHTHYOPHTHIRIUS ...3.0100
ISOLATION AND FURTHER DESCRIPTION OF THE SPORES OF MYXOSOMA CEREBRALIS ...3.0101
LONGEVITY OF SPORES OF 'MYOXOSOMA CEREBRALIS' (WHIRLING DISEASE) ...3.0102
IMMUNODIAGNOSIS OF WHIRLING DISEASE (MYXOSOMA CEREBRALIS) ...3.0103
VERTEBRATE DISEASES - VIRAL DISEASES OF FRESHWATER FISHES AND OTHER LOWER VERTEBRATES EGTVED VIRUS ...3.0104
POSSIBLE BIRD TRANSMISSION OF 'MYXOSOMA CEREBRALIS' ...3.0105
MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...3.0106
DIAGNOSIS OF DISEASES IN FISH ...3.0107
PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...3.0108
CONTROL OF MYXOSPORIDIAN PARASITES ...3.0109
SPAWNING AND REARING OF MARINE FISH ...3.0110
PATHOLOGY - EPIZOOTIOLOGY ...3.0113
DISEASE-RESISTANT OYSTERS ...3.0114
REPRODUCTION & FUNGAL PARASITES AFFECTING REPRODUCTION IN LOBSTER, HUMARUS AMERICANNA, & BLUE CRAB CALLINECTES SAPIDUS, IN N.C. WATERS ...3.0115
RELATIONSHIP OF TEMPERATURE TO DISEASES OF SALMONID FISH ...3.0116
CONTROL OF VIBRIOSIS IN SALMON ...3.0117
AQUICULTURE, OYSTER HATCHERIES - RESEARCH ...3.0118
EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...3.0119
EVALUATION OF STRESS IN FINGERLING SALMON THERAPEUTIC DRUGS AS STRESS FACTORS ...3.0120
IN VIVO CHEMOTHERAPEUTIC STUDIES ON FISH PATHOGENIC BACTERIA ...3.0121
ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - FURUNCULOSIS IN COHO SALMON ...3.0122
CHEMOTHERAPEUTIC STUDIES ON FISH PATHOGENIC BACTERIA ...3.0123
BIOCHEMICAL CHANGES IN FISH DISEASES - THE STRESS OF FORMALIN TREATMENTS IN SALMONID FISHES ...3.0124
EFFICACY OF A POTENTIATED SULFONAMIDE AGAINST FURUNCULOSIS INFECTIONS IN JUVENILE RAINBOW TROUT AND COHO SALMON ...3.0125
AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...3.0126
CHEMOTHERAPY OF FISH DISEASES ...3.0127

PARASITES AND PARASITIC DISEASES OF FISHES - STUDY OF NEW METHODS FOR CONTROL OF ICHTHYOPHT ...3.0128

CONTROL OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA FILTRATION AND ULTRAVIOLET IRRADIATION ...3.0129

EFFECT OF DISINFECTING AGENTS ON M. CEREBRALIS ...3.0130

TRANSMISSION OF MICROSPORIDA ...3.0131

TRANSMISSION OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA ...3.0132

THE TOXICITY AND DRUG RESIDUE LEVEL OF CHLORAMPHENICOL IN TREATED RAINBOW TROUT ...3.0133

DIAGNOSIS OF DISEASES IN WILDLIFE ...3.0134

FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES ...4.0080

NORTHERN PIKE LIFE HISTORY STUDY ...4.0084

WALLEYE LIFE HISTORY STUDY ...4.0085

Spawning & Nesting Sites

QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...1.0259

EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE 1 ...2.0073

SQUAWFISH CONTROL IN CASCADE RESERVOIR ...2.0195

ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202

TRIBUTARY SURVEY OF LAKES ONTARIO AND ERIE ...2.0220

PRE-LAMPREY CONTROL INVENTORY OF FISH STOCKS ...2.0222

EXPERIMENTS TO RE-ESTABLISH HISTORICAL OYSTER SEED GROUNDS AND TO CONTROL THE SOUTHERN OYSTER DRILL ...2.0274

EFFECTS OF WATER EXCHANGE AND BLUE CRAB CONTROL ON SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IMPOUNDMENTS ...2.0275

MOLLUSCAN MORTALITY STUDIES ...3.0032

WALLEYE AND NORTHERN PIKE STUDY ...3.0072

GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081

REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES ...4.0083

Stocking of Fish & Shellfish

FISHERY RESOURCES PROGRAM ...1.0317

EVALUATION OF GIZZARD SHAD AS A FORAGE FISH ...1.0356

EXPERIMENTAL INTRODUCTION OF EXOTIC FRESHWATER FISHES ...2.0131

SMALL IMPOUNDMENT STOCKING ...2.0190

STRIPED BASS STUDIES ...2.0193

BIOLOGICAL AND LIMNOLOGICAL INVENTORY OF SEVEN FLOOD CONTROL RESERVOIRS IN THE STATE OF INDIANA ...2.0199

ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202

EXPERIMENTAL ESTABLISHMENT OF MONOSPECIFIC WALLEYE POPULATIONS AS A MANAGEMENT MEASURE FOR SMALL WARMWATER LAKES IN NORTHERN MINNESOTA ...2.0214

EXPERIMENTAL RESTORATION OF THE GILA TROUT ...2.0218

PLANNING FOR CREATION OF SALMONID FISHERIES IN LAKE ONTARIO ...2.0221

PRE-LAMPREY CONTROL INVENTORY OF FISH STOCKS ...2.0222

ASSESSMENT OF LAKE TROUT AND ASSOCIATED SPECIES IN LAKES MICHIGAN AND SUPERIOR ...2.0264

EXPERIMENTS TO RE-ESTABLISH HISTORICAL OYSTER SEED GROUNDS AND TO CONTROL THE SOUTHERN OYSTER DRILL ...2.0274

PACIFIC OYSTER MORTALITY STUDIES ...3.0034

REFINEMENT OF MANAGEMENT TECHNIQUES FOR STREAM TROUT LAKES ...3.0035

INVENTORY OF WATERS OF THE PROJECT AREA ...3.0039

TESTS OF SELECTED SEED OYSTER STOCKS ON COMMERCIAL BEDS ...3.0079

INVESTIGATION OF HANDLING TECHNIQUES ...3.0111

EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...3.0119

POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078

Tags

MERIDIAN STATE PARK LAKE CRAPPIE REMOVAL EXPERIMENT ...2.0231

NORTHERN PIKE LIFE HISTORY STUDY ...4.0084

WALLEYE LIFE HISTORY STUDY ...4.0085

Floods

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039

MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...2.0060

COORDINATION OF MOSQUITO CONTROL IN NEW JERSEY ...2.0061

Florida

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029

ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN ...1.0132

UPPER ST. JOHNS RIVER BASIN WATER QUALITY, FLORIDA ...1.0134

TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005

Flow Augmentation

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168

NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180

Flow Characteristics -water

POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...1.0036

SEA LAMPREY CONTROL - LAKE HURON CHEMICAL CONTROL ...2.0204

LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...2.0205

LAKE HURON CHEMICAL CONTROL ...2.0209

Flow Types - Natural Water

TRIBUTARY SURVEY OF LAKES ONTARIO AND ERIE ...2.0220

Low Flow

TRIBUTARY SURVEY OF LAKES ONTARIO AND ERIE ...2.0220

Peak Flow

TRIBUTARY SURVEY OF LAKES ONTARIO AND ERIE ...2.0220

Stratified Flow

NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180

Flume Studies

INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106

Fluorescein

NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...**1.0027**

Fluorescent

SOILS, PESTICIDES, AND THE QUALITY OF WATER ...**1.0103**

DEVELOPMENT OF RHODAMINE-B DYE TO TRACE FLOW AND DISPERSION PATTERNS IN STREAMS AS AN ADJUNCT TO TREATING STREAMS WITH FISH-CONTROL CHEMICALS ...**2.0245**

Food -fish -shellfish

PESTICIDE CONTAMINATION OF ENVIRONMENT ...**1.0250**

QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...**1.0259**

TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...**1.0344**

VERTEBRATE DISEASES - VIRAL DISEASES OF FRESHWATER FISHES AND OTHER LOWER VERTEBRATES EGTVED VIRUS ...**3.0104**

LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN ...**4.0082**

Food Chains, Animal or Man

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0037**

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...**1.0038**

REDUCTION OF PESTICIDE RESIDUE HAZARDS ...**1.0040**

METABOLISM OF ENDRIN IN PONDS ...**1.0113**

CHEMICAL ANALYSES ...**1.0129**

ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN ...**1.0132**

RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS ...**1.0138**

TOXAPHENE CONTAMINATION - ESTUARINE ECOLOGY ...**1.0139**

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...**1.0143**

THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...**1.0144**

LIMNOLOGICAL FACTORS AFFECTING PESTICIDE RESIDUES IN SURFACE WATERS ...**1.0149**

GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...**1.0152**

PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...**1.0163**

OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...**1.0219**

PESTICIDES RESEARCH ...**1.0232**

PESTICIDE CONTAMINATION OF ENVIRONMENT ...**1.0250**

EFFECTS OF PARATHION AND MALATHION ON WARMWATER FISH PONDS ...**1.0283**

THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...**1.0297**

PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES ...**1.0306**

THE CHEMISTRY AND TOXICOLOGY OF AGRICULTURAL CHEMICALS ...**1.0322**

INVESTIGATION OF MEANS FOR CONTROLLED SELF-DESTRUCTION OF PESTICIDES ...**1.0323**

PESTICIDES AND WILDLIFE ...**1.0324**

SELECTED PESTICIDES VS. WILDLIFE IN AQUATIC ENVIRONMENTS ...**1.0325**

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...**1.0328**

FATE OF AQUATIC HERBICIDES IN THE AQUATIC ENVIRONMENT ...**1.0329**

THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...**1.0330**

DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...**1.0333**

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...**1.0334**

IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS ...**1.0335**

STUDY OF CHRONIC TOXICITY OF LINDANE TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...**1.0337**

MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS ...**1.0338**

ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...**1.0339**

FARM FISH POND MANAGEMENT ...**1.0340**

AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...**1.0343**

SELECTED PESTICIDES IN AQUATIC FUNGI IN THE THREE RIVERS AREA ...**1.0345**

TOXICITY HAZARD OF POLYCHOLORINATED BIPHENYLS TO AQUATIC LIFE ...**1.0347**

INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0351**

BIODEGRADATION OF PESTICIDES IN A FRESHWATER ECOSYSTEM - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0352**

STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970 ...**1.0354**

PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...**1.0358**

TOXICOLOGY OF PESTICIDES IN THE ENVIRONMENT ...**1.0360**

ENVIRONMENTAL TOXICOLOGY OF PESTICIDES ...**1.0361**

PHARMACOLOGICAL AND ECOLOGICAL EFFECTS OF PESTICIDES ...**1.0362**

CHEMICAL BIOCIDES IN LAKES ...**1.0364**

INSECTICIDES AND EGG-SHELL DEPOSITION ...**1.0368**

BIOLOGICAL FACTORS IN THE MANAGEMENT OF LAKE FLIES ...**2.0088**

CHEMICAL CONTROL OF WEEDS IN PONDS ...**2.0093**

WEED CONTROL IN RICE PRODUCTION ...**2.0097**

MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...**2.0124**

INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...**2.0167**

Food Contamination

THE CHEMISTRY AND TOXICOLOGY OF AGRICULTURAL CHEMICALS ...**1.0322**

TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...**1.0344**

Food Preparation

TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...**1.0344**

Food Quality

Chemical Analysis of Food

QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...**1.0259**

TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...**1.0344**

Food Cooked Quality

QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...1.0259

TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...1.0344

Organoleptic Studies

Aroma

QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...1.0259

Flavor & Taste

QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...1.0259

Texture & Tenderness

QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...1.0259

Shelf Life and Storage

QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...1.0259

VERTEBRATE DISEASES - VIRAL DISEASES OF FRESHWATER FISHES AND OTHER LOWER VERTEBRATES EGTVED VIRUS ...3.0104

Food Spoilage

TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...1.0344

VERTEBRATE DISEASES - VIRAL DISEASES OF FRESHWATER FISHES AND OTHER LOWER VERTEBRATES EGTVED VIRUS ...3.0104

Forage Grasses

QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204

STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...2.0159

Forecasting - Prediction

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...4.0018

Foreign Agriculture

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010

POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038

MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085

SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...2.0095

THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...2.0130

NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135

NATURAL ENEMIES OF EURASIAN WATERMILFOIL IN PAKISTAN ...2.0173

METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186

NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188

BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...4.0058

INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...4.0059

RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070

Forestry

RESPROUTING OF CHAPARRAL ...1.0017

AN EVALUATION OF THE INSECTICIDE 'SEVIN' AS A WATERSHED POLLUTANT ...1.0067

ENVIRONMENTAL BIOLOGY - BIOGEOCHEMICAL CYCLING IN ECOLOGICAL SYSTEMS ...1.0068

BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083

FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...2.0142

Formaldehyde

INVESTIGATION OF HANDLING TECHNIQUES ...3.0111

BIOCHEMICAL CHANGES IN FISH DISEASES - THE STRESS OF FORMALIN TREATMENTS IN SALMONID FISHES ...3.0124

Formulation -physical

VOLATILIZATION LOSSES OF PESTICIDES FROM SOILS ...1.0016

CONSTRUCTION OF PESTICIDES DEGRADABLE BY NORMAL MICROFLORA OF NATURAL WATERS AND SOILS ...1.0331

CONTROL OF COMMON HOUSEFLY ...2.0005

THE EFFICACY AND PERSISTENCE OF FORMULATIONS OF ANTIMYCIN ...2.0244

METHOD OF KILLING ONCOMELANIA & AQUATIC SNAIL VECTORS OF SCHISTOSOMIASIS ...2.0285

Aerosols - Smokes, Fogs, Stem

BIOLOGICAL EVALUATION OF INSECT CONTROL AGENTS ...2.0050

BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057

NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077

Baits, Lures

SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...2.0028

BIOLOGY AND CONTROL OF SNAILS ...2.0268

'A METHOD OF DESTROYING ONCOMELANIA-THE SNAIL VECTOR OF SCHISTOSOMIASIS' ...2.0284

METHOD OF KILLING ONCOMELANIA & AQUATIC SNAIL VECTORS OF SCHISTOSOMIASIS ...2.0285

DEVELOPMENT OF A TOXIC BAIT ...2.0286

BIOLOGY AND CONTROL OF TERRESTIAL MOLLUSKS ...2.0289

THE CONTROL OF SLUGS ...2.0294

Carriers--non-liquid

THE EFFICACY OF NEW FORMULATIONS OF ANTIMYCIN IN NATURAL LAKES AND STREAMS ...2.0246

Concentrates

AERIAL DISPERSAL METHODS FOR CONCENTRATED INSECTICIDES ...2.0009

CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...2.0154

BIOLOGY AND CONTROL OF SNAILS ...2.0268

Dusts

ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001

RELATION OF APPLICATION METHODS, CONCENTRATION, AND VOLUME OF INSECTICIDE TO CATTLE INSECT CONTROL ...2.0039

BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...2.0040

ABUNDANCE, DISTRIBUTION AND CONTROL OF MISCELLANEOUS INSECTS, AFFECTING LIVESTOCK ...2.0056
INSECTS AFFECTING MAN AND ANIMALS ...2.0081
EFFECT OF BITING FLIES ON WEIGHT GAINS IN CATTLE ...2.0090

Emulsifiers

AROMATIC SOLVENT AQUATIC HERBICIDES AND EMULSIFYING AGENT TESTING ...2.0107

Granules, Capsules

WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...1.0005
DEVELOPMENT OF A TECHNIQUE FOR THE CONTROLLED SELF-DESTRUCTION OF FIELD-APPLIED DDT ...1.0014
ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
CONTROL OF COMMON HOUSEFLY ...2.0005
NEW INSECTICIDES & TECHNIQUES FOR PEST CONTROL ...2.0016
CONTROL OF AQUATIC WEEDS ...2.0113
CHEMICAL CONTROL OF DITCHBANK WEEDS IN PEAT AND SANDY SOIL AREAS OF SOUTH FLORIDA ...2.0114
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0118
THE EFFICACY OF NEW FORMULATIONS OF ANTIMYCIN IN NATURAL LAKES AND STREAMS ...2.0246
'A METHOD OF DESTROYING ONCOMELANIA-THE SNAIL VECTOR OF SCHISTOSOMIASIS' ...2.0284

Impregnated Materials-products

NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077
INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106
MARINE PILING ANALYSIS ...2.0296

Liquids or Sprays

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0091
ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
NEW INSECTICIDES & TECHNIQUES FOR PEST CONTROL ...2.0016
MALARIA ERADICATION RESEARCH ...2.0051
TESTING OF METHODS OF HERBICIDE APPLICATION ...2.0126

Low Volume

COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
AERIAL DISPERSAL METHODS FOR CONCENTRATED INSECTICIDES ...2.0009
RELATION OF APPLICATION METHODS, CONCENTRATION, AND VOLUME OF INSECTICIDE TO CATTLE INSECT CONTROL ...2.0039
COORDINATION OF MOSQUITO CONTROL IN NEW JERSEY ...2.0061
ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE ...4.0031

Solids

THE EFFICACY OF NEW FORMULATIONS OF ANTIMYCIN IN NATURAL LAKES AND STREAMS ...2.0246

Solvents or Carriers

MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS ...1.0028
AROMATIC SOLVENT AQUATIC HERBICIDES AND EMULSIFYING AGENT TESTING ...2.0107

Surfactants - Wetting Agents

MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS ...1.0028
DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...1.0196

Wettable Powders

COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
DEVELOPMENT OF ACCURATE CHEMICAL INTRODUCTION TECHNIQUES ...2.0223

France

PATHOLOGY - EPIZOOTIOLOGY ...3.0113

Fungal Physiology

Environment

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082

Growth and Differentiation

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082
CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS ...2.0265

Metabolism

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082
SELECTED PESTICIDES IN AQUATIC FUNGI IN THE THREE RIVERS AREA ...1.0345
MODE OF ACTION OF A NEW FUNGAL PATHOGEN OF MOSQUITOES ...2.0070

Pathological Physiology

MODE OF ACTION OF A NEW FUNGAL PATHOGEN OF MOSQUITOES ...2.0070
POTENTIAL OF COELOMOMYCES FOR CONTROLLING MOSQUITOES ...2.0071

Virulence

NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188

Fungi

AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...3.0126

Alternaria

NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135

Aspergillus

TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...2.0007
IDENTIFICATION AND CHARACTERIZATION OF MOSQUITO PATHOGENS ...2.0020

Ceratocystis

CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS ...2.0265

Cercospora

NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135

Coelomomyces

- CULTIVATION OF COELOMOMYCES, A FUNGAL PARASITE OF MOSQUITOES ...2.0031
- BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043
- POTENTIAL OF COELOMOMYCES FOR CONTROLLING MOSQUITOES ...2.0071
- STUDIES ON SOME FUNGAL PARASITES OF MOSQUITOES ...2.0072

Dermocystidium

- TESTING OF STOCKS OF OYSTERS FOR DISEASE RESISTANCE ...3.0077

Endothia

- MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082

Entomophthora

- BIOLOGY OF MICROORGANISMS OF MOSQUITOES ...2.0022

Fungi -nonspecific

- TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...2.0007
- BIOLOGICAL CONTROL OF INSECTS AFFECTING MAN ...2.0027
- INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...2.0029
- FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...2.0053
- ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089
- REPRODUCTION & FUNGAL PARASITES AFFECTING REPRODUCTION IN LOBSTER, HUMARUS AMERICANNA, & BLUE CRAB CALLINECTES SAPIDUS, IN N.C. WATERS ...3.0115

Fusarium

- MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082
- PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...1.0087
- SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105
- NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188

Lenzites

- ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089

Metarrhizium

- MODE OF ACTION OF A NEW FUNGAL PATHOGEN OF MOSQUITOES ...2.0070

Plant Pathogenetic Fungi

- BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...2.0121

Saprolegniaceae

- SELECTED PESTICIDES IN AQUATIC FUNGI IN THE THREE RIVERS AREA ...1.0345

Yeasts -nonspecific

- FEEDING HABITS OF MOSQUITO LARVAE ...4.0034

Gaging

- POLLUTION LOADS IN RUNOFF FROM SMALL AGRICULTURAL WATERSHEDS ...1.0154

Gameteocides

- STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES ...2.0256

Gantrisin

- CHEMOTHERAPY OF FISH DISEASES ...3.0127

Gases, Dissolved -water

- PROPERTIES OF TILE DRAINAGE WATER ...1.0045
- ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120
- QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187
- RESEARCH STUDY ON THE EFFECTS OF POLLUTION ON SUB-TROPICAL FISH AND CRUSTACEANS ...1.0237
- CONTROL OF BLACK FLIES AND MOSQUITOES IN MAINE ...2.0046
- CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...2.0185
- PISCICIDE TOXICOLOGY OF THE CYPRINIDS IN EAST AND WEST PAULINA LAKES ...2.0223
- EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT) ...2.0229
- EVALUATE FISH TOXICANT (ANTIMYCIN) (EAGLE LAKE SEGMENT) ...2.0230
- COOPERATIVE FISH PARASITE AND DISEASE STUDY ...3.0015
- ETIOLOGY OF ESTUARINE FISH DISEASES ...3.0040
- MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...3.0060
- MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082
- EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...3.0083
- CORRELATE NITROGEN GAS CONTENT OF WATER SUPPLIES WITH DISEASE ...3.0088
- THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER ...4.0004
- WATER QUALITY REQUIREMENTS OF AQUATIC INSECTS ...4.0066
- POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078
- REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES ...4.0083

Genetics

Chromosomal Inversion

- RADIATION CYTOGENETICS OF THE YELLOW-FEVER MOSQUITO, AEDES AEGYPTI ...2.0036
- GENETIC STUDIES ON THE CONTROL OF ARBOVIRUS VECTORS ...2.0048

Chromosomal Translocation

- GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...2.0034
- RADIATION CYTOGENETICS OF THE YELLOW-FEVER MOSQUITO, AEDES AEGYPTI ...2.0036
- POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038
- GENETIC STUDIES ON THE CONTROL OF ARBOVIRUS VECTORS ...2.0048

Chromosome Mapping

- GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055

Chromosome Markers

- SUPPLYING GENETIC MARKER AND INCOMPATIBLE STRAINS OF CULEX PIPIENS ...2.0012
- POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038
- THE BIOLOGY AND CONTROL OF THE SNAIL INTERMEDIATE HOST OF SCHISTOSOMES ...2.0276
- GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055

Crossbreeding Techniques

GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...2.0034
INTERSPECIFIC COMPETITION AMONG MOSQUITOES ...2.0047
BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS ...4.0061

Cytoplasmic Inheritance

CYTOPLASMIC INCOMPATIBILITY FOR FILARIASIS CONTROL ...2.0013
CYTOPLASMIC INHERITANCE AND CONTROL OF CULEX PIPIENS ...2.0041

Disease and Anomalies

SUSCEPTIBILITY OF OTHER SPECIES OF CATFISHES TO CCV AND THEIR POSSIBLE ROLE AS CARRIERS ...3.0007

Genotypes

GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...2.0034

Incompatibility

CYTOPLASMIC INCOMPATIBILITY FOR FILARIASIS CONTROL ...2.0013
CYTOPLASMIC INHERITANCE AND CONTROL OF CULEX PIPIENS ...2.0041
GENETIC STUDIES ON THE CONTROL OF ARBOVIRUS VECTORS ...2.0048

Karyotypes

THE BIOASSAY OF WATER POLLUTANTS WITH CULTURED MAMMALIAN CELLS ...1.0200
POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038

Meiosis

GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...2.0034
GENETIC STUDIES ON THE CONTROL OF ARBOVIRUS VECTORS ...2.0048
GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055

Mitosis

GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...2.0034

Mutation

Lethal Mutation

GENETIC STUDIES ON THE CONTROL OF ARBOVIRUS VECTORS ...2.0048
GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055

Mutagenesis

RADIATION CYTOGENETICS OF THE YELLOW-FEVER MOSQUITO, AEDES AEGYPTI ...2.0036
GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055

Somatic Mutation

POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038

Spontaneous Mutation

POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038

Natural Resistance

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...1.0249
STUDIES ON INSECTICIDE RESISTANCE IN MOSQUITOES ...2.0017
INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...2.0029
THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078
THE EFFECTS OF ANTIMYCIN A ON THE METABOLISM OF SELECTED TISSUES IN FISH (ABBREV) ...2.0262
TESTING OF STOCKS OF OYSTERS FOR DISEASE RESISTANCE ...3.0077
ACQUIRED VS. GENETIC RESISTANCE IN OYSTERS ...3.0078
DISEASE-RESISTANT OYSTERS ...3.0114
BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...4.0045
GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055

Phenotypes

GENETIC STUDIES ON THE CONTROL OF ARBOVIRUS VECTORS ...2.0048
BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS ...4.0061

Polytene Chromosomes

POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038

Population Genetics

POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038
THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...4.0052
RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070

Selection & Breeding

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...1.0249
STUDIES ON INSECTICIDE RESISTANCE IN MOSQUITOES ...2.0017
CYTOPLASMIC INHERITANCE AND CONTROL OF CULEX PIPIENS ...2.0041
RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT FINGERLINGS TO FURUNCULOSIS ...3.0041
RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT YEARLINGS TO FURUNCULOSIS ...3.0042
FIELD TESTING OF SELECTIVELY BRED STRAINS OF BROOK AND BROWN TROUT UNDER PRODUCTION HATCHERY CONDITIONS ...3.0043
AQUICULTURE, OYSTER HATCHERIES - RESEARCH ...3.0118

Recombination

Linkage

POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038
GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055

Recombination -other

BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS ...4.0061

Sex Linkage

RADIATION CYTOGENETICS OF THE YELLOW-FEVER MOSQUITO, AEDES AEGYPTI ...2.0036

Sex Reversal

THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...4.0052

Sterility -genetic

CYTOPLASMIC INHERITANCE AND CONTROL OF CULEX PIPIENS ...2.0041

Geographic Factors

CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266
ASSESSMENT OF THE IMPORTANCE OF FILARIASIS IN THAILAND ...4.0072

Geomorophology

ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS ...1.0049
CONTROL OF PESTICIDES IN SOIL AND WATER ...1.0054
GREEN BAY RESEARCH PROGRAM ...1.0112
SEA LAMPREY CONTROL - LAKE HURON CHEMICAL CONTROL ...2.0204
INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...4.0001
INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...4.0059

Georgia

TOXAPHENE CONTAMINATION - ESTUARINE ECOLOGY ...1.0139
MALARIA ERADICATION RESEARCH ...2.0051

Geraniol

CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266

Gibberellin

GROWTH REGULATORS AND MINERAL NUTRITION IN AQUATIC PLANT CONTROL ...2.0134

Glaciology

DDT IN SNOW FALLEN AT HIGH ALTITUDE SINCE 1950 ...1.0214

Glass

PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105

Goitrogens

DEVELOPMENT OF METHODS FOR COMMERCIAL PRODUCTION OF FROG LEGS FROM TADPOLES OF THE BULLFROG ...3.0028

Gravity

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...1.0236

Grazing

EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...1.0074

Great Lakes

GREAT LAKES PESTICIDE MONITORING PROGRAM, INDIANA ...1.0147
MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...1.0160
PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0163
PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0164
FISHERY RESOURCES PROGRAM ...1.0317
SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...2.0206
SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...2.0207
SEA LAMPREY CONTROL - ASSESSMENT METHODS ...2.0208
BIOLOGY OF THE LARVAL SEA LAMPREY ...2.0210

Lake Erie

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0192
PESTICIDES MOVEMENT FROM CROPLAND INTO LAKE ERIE ...1.0193
PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES ...1.0306
TRIBUTARY SURVEY OF LAKES ONTARIO AND ERIE ...2.0220
INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...4.0027

Lake Huron

SEA LAMPREY CONTROL - LAKE HURON CHEMICAL CONTROL ...2.0204
LAKE HURON CHEMICAL CONTROL ...2.0209

Lake Michigan

GREEN BAY RESEARCH PROGRAM ...1.0112
PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...1.0143
WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...1.0162
PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166
EVALUATION OF PESTICIDE SOURCES AND LEVELS TRIBUTARY TO LAKES MICHIGAN AND SUPERIOR ...1.0221
TERMINAL RESIDUES OF CHLORINATED HYDROCARBON PESTICIDES IN LAKE MICHIGAN AND ASSOCIATED TRIBUTARIES ...1.0222
CHLORINATED ORGANIC CONTAMINANTS IN THE MILWAUKEE RIVER ...1.0226
RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...1.0256
QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...1.0259
BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH ...1.0261
MAGNITUDE AND NATURE OF POLYCHLORINATED BIPHENYLS IN COHO SALMON ...1.0262
PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...1.0328
PESTICIDE LEVELS IN BIRDS WINTERING ON LAKE MICHIGAN ...1.0367
INSECTICIDES AND EGG-SHELL DEPOSITION ...1.0368
ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202
SEA LAMPREY CONTROL - LAKE MICHIGAN CHEMICAL CONTROL ...2.0203
ASSESSMENT OF LAKE TROUT AND ASSOCIATED SPECIES IN LAKES MICHIGAN AND SUPERIOR ...2.0264
MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...3.0106

Lake Ontario

TRIBUTARY SURVEY OF LAKES ONTARIO AND ERIE ...2.0220
PLANNING FOR CREATION OF SALMONID FISHERIES IN LAKE ONTARIO ...2.0221
PRE-LAMPREY CONTROL INVENTORY OF FISH STOCKS ...2.0222
LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN ...4.0082

Lake Superior

PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166

PRESTICIDE INPUTS AND LEVELS IN MINNESOTA WATERS OF THE LAKE SUPERIOR BASIN ...1.0167

EVALUATION OF PESTICIDE SOURCES AND LEVELS TRIBUTARY TO LAKES MICHIGAN AND SUPERIOR ...1.0221

RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...1.0256

BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH ...1.0261

LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...2.0205

LAKE SUPERIOR COMMERCIAL FISHERIES ASSESSMENT STUDIES ...2.0212

POPULATION DYNAMICS - LAKE TROUT ...2.0235

ASSESSMENT OF LAKE TROUT AND ASSOCIATED SPECIES IN LAKES MICHIGAN AND SUPERIOR ...2.0264

LAKE SUPERIOR PERIPHYTON IN RELATION TO WATER QUALITY ...4.0017

Greece

THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...2.0130

Groundwater

SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL ...1.0012

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013

BEHAVIOR OF POLLUTANTS IN WATER ...1.0022

POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...1.0036

EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065

SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...1.0066

MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...1.0071

SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072

FATE OF POLLUTANTS IN GROUND WATER ...1.0079

EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS ...1.0080

FATES OF AGRICULTURAL CHEMICALS IN SOILS ...1.0092

PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...1.0094

MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...1.0098

MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099

EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...1.0100

CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...1.0189

INVESTIGATION OF RICE IRRIGATION RETURN FLOWS - TEXAS COASTAL PRAIRIE REGION ...1.0209

NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...4.0015

Growth Retardation of Plants

GROWTH REGULATORS AND MINERAL NUTRITION IN AQUATIC PLANT CONTROL ...2.0134

Gums -nonspecific

ALLEVIATION OF LAKE POLLUTION BY UTILIZATION OF AQUATIC PLANTS FOR NUTRITIONAL, MEDICINAL OR INDUSTRIAL PURPOSES ...2.0152

Halogens

CONSTRUCTION OF PESTICIDES DEGRADABLE BY NORMAL MICROFLORA OF NATURAL WATERS AND SOILS ...1.0331

Bromine

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

Chlorie

DEVELOPMENT OF TREATMENT PROCESS FOR CHLORINATED HYDROCARBON PESTICIDE MANUFACTURING AND PROCESSING WASTES ...1.0118

ORGANIC SUBSTANCES IN WATER ...1.0119

ADSORPTION OF PESTICIDES FROM SEA WATER ...1.0159

Chlorine

PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...1.0033

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086

ANALYTICAL METHODS FOR PESTICIDES AND PESTICIDE DEGRADATION PRODUCTS ...1.0088

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269

SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0273

TIME-CONCENTRATION TESTS INVOLVING NEUTRALIZATION OF ROTENONE WITH POTASSIUM PERMANGANATE ...2.0224

Iodine

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

Hawaii

POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...1.0036

Heating & Ventilation

THE USE OF FLAME FOR CONTROLLING WEEDS AND BRUSH ...2.0136

Hemorrhagic Disorders

VERTEBRATE DISEASES - VIRAL DISEASES OF FRESHWATER FISHES AND OTHER LOWER VERTEBRATES EGTVED VIRUS ...3.0104

Hexanes

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013

History of Pesticide Usage

PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...1.0170

CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0210

THE RELATIONSHIP BETWEEN THE USE OF AGRICULTURAL CHLORINATED HYDROCARBONS AND THEIR RESIDUES IN CHANNEL CATFISH ...1.0298

Hormones

RESPROUTING OF CHAPARRAL ...1.0017

ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089

STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES ...2.0256

Arthropod Hormones

CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266

Auxin

RESPROUTING OF CHAPARRAL ...1.0017

Gonadotrophins -nonspecific

EFFECTS ON THE SPERMIATION RESPONSE OF GOLDFISH AFTER EXPOSURE TO SELECTED PESTICIDES ...1.0270

Hydrocortisone

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269

EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...3.0089

Plant Hormones -general

CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266

Horticulture

NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0027

WEED CONTROL IN CITRICULTURE ...2.0123

THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...2.0150

BIOLOGY AND CONTROL OF TERRESTIAL MOLLUSKS ...2.0289

Humidity

MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS ...1.0011

MODE OF ACTION OF A NEW FUNGAL PATHOGEN OF MOSQUITOES ...2.0070

DISTRIBUTION AND ECOLOGY OF PENNSYLVANIA SALAMANDERS ...2.0080

BIOLOGY AND CONTROL OF TERRESTRIAL MOLLUSCS ...2.0281

DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053

Hydrocarbons

IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD ...1.0123

ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...1.0153

INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106

Hydrogen

LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010

Hydrology -general

EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...1.0074

RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY ...4.0002

INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...4.0059

Hydrolysis

RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146

Illinois

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...1.0328

ILLINOIS LAWS AFFECTING AGRICULTURE ...1.0332

Immunity

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045

JAPANESE ENCEPHALITIS ON GUAM ...4.0062

Immunoelectrophoresis

THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...4.0052

India

NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135

Indiana

BIOLOGICAL AND LIMNOLOGICAL INVENTORY OF SEVEN FLOOD CONTROL RESERVOIRS IN THE STATE OF INDIANA ...2.0199

Industrial Wastes

Chemical Manufacturing Wastes

CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0093

DEVELOPMENT OF TREATMENT PROCESS FOR CHLORINATED HYDROCARBON PESTICIDE MANUFACTURING AND PROCESSING WASTES ...1.0118

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183

DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...1.0184

CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0210

Disposal Wastes

CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0093

Dye Wastes

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183

DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...1.0184

Metal Processing Wastes

DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...1.0184

Organic Wastes

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183

Treatment

CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0093

DEVELOPMENT OF TREATMENT PROCESS FOR CHLORINATED HYDROCARBON PESTICIDE MANUFACTURING AND PROCESSING WASTES ...1.0118

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183

Industries

CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0210

Chemical Industry

CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0093

Pulp, Paper , and Logging

TOXICITY OF POLLUTANTS TO STRIPED BASS ...1.0251

Slaughter Houses & Proc Plants

ILLINOIS LAWS AFFECTING AGRICULTURE ...1.0332

Infiltration

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013

BEHAVIOR OF POLLUTANTS IN WATER ...1.0022

POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...1.0036

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0085

PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...1.0094

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105

Inflow

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029

Information Systems

Abstracting

PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...1.0199

Data & Statistics Info Storage

WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...1.0162

EVALUATION OF PESTICIDE SOURCES AND LEVELS TRIBUTARY TO LAKES MICHIGAN AND SUPERIOR ...1.0221

Document & Literature Info

PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...1.0199

Indexing

PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...1.0199

Insects

Anoplura

ABUNDANCE, DISTRIBUTION AND CONTROL OF MISCELLANEOUS INSECTS, AFFECTING LIVESTOCK ...2.0056

THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078

Coleoptera

CLASSIFICATION, BIONOMICS, ECOLOGY CONTROL OF FOREST INSECTS (OTHER THAN SCOLYTIDAE) IN CAL. ...1.0321

ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001

BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS ...2.0054

Bruchidae

ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

Chrysomelidae

MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...1.0266

EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...2.0002

FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...2.0053

BIOLOGICAL CONTROL OF WEEDS ...2.0099

BIOLOGICAL CONTROL OF WEEDS ...2.0102

SOUTHEASTERN BIOLOGICAL CONTROL OF WEEDS INVESTIGATIONS ...2.0120

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0129

NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135

DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053

Coccinellidae

EMERGENCY INSECT CONTROL ...2.0076

Cucujidae

STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS ...2.0067

Curculionidae

PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...1.0075

CLASSIFICATION, BIONOMICS, ECOLOGY CONTROL OF FOREST INSECTS (OTHER THAN SCOLYTIDAE) IN CAL. ...1.0321

INSECT SURVEY OF MONTANA ...2.0058

SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...2.0095

BIOLOGICAL CONTROL OF WEEDS ...2.0099

NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135

INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...2.0144

NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188

DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053

Scolytidae

FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...2.0053

Staphylinidae

BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057

INSECT SURVEY OF MONTANA ...2.0058

INSECTS AFFECTING MAN AND ANIMALS ...2.0081

Tenebrionidae

MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...1.0266

EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...2.0002

SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...2.0055

Collembola

EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS ...1.0341

EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...2.0002

Dermaptera

EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...2.0002

Diptera

WATER QUALITY REQUIREMENTS OF AQUATIC INSECTS ...4.0066

Aedes

EFFECT OF MOSQUITO CONTROL CHEMICALS ON AQUATIC FAUNA ...2.0003
BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...2.0006
BIOLOGY AND CONTROL OF PASTURE MOSQUITOES ...2.0008
BIOLOGY AND CONTROL OF MOSQUITOES IN IRRIGATED AND WATER MANAGEMENT AREAS ...2.0011
SUPPRESSION AND ECOLOGY OF MOSQUITOES ...2.0018
MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...2.0019
BIOLOGY OF MICROORGANISMS OF MOSQUITOES ...2.0022
DEVELOPMENT AND BEHAVIOR OF BITING DIPTERA ...2.0023
INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025
INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...2.0029
INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...2.0030
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS ...2.0033
RADIATION CYTOGENETICS OF THE YELLOW-FEVER MOSQUITO, AEDES AEGYPTI ...2.0036
BIOLOGY AND ECOLOGY OF SALT-MARSH MOSQUITOES OF LOUISIANA ...2.0042
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043
CONTROL OF BLACK FLIES AND MOSQUITOES IN MAINE ...2.0046
INTERSPECIFIC COMPETITION AMONG MOSQUITOES ...2.0047
GENETIC STUDIES ON THE CONTROL OF ARBOVIRUS VECTORS ...2.0048
MALARIA ERADICATION RESEARCH ...2.0051
SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...2.0055
MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...2.0060
STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS ...2.0067
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE I ...2.0073
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...2.0075
THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...2.0079
DISTRIBUTION AND ECOLOGY OF PENNSYLVANIA SALAMANDERS ...2.0080
EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082
INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087
DEVELOPMENT OF CULTURE METHODS FOR MOSQUITOES ...4.0035
CULTIVATION OF INSECT PHASE OF AVIAN PLASMODIA ...4.0036
MOSQUITOES OF MIDDLE AMERICA ...4.0037
ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...4.0039
(U) REPELLENCY AND ATTRACTIVENESS OF MAN TO MOSQUITO BITES ...4.0040
THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...4.0052
DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053
GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055
ARTHROPOD-BORNE VIRUS (ARBOVIRUS) ACTIVITY IN MAJOR MOSQUITO VECTORS IN IOWA ...4.0057
BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS ...4.0061
BIONOMICS OF MARYLAND MOSQUITOES ...4.0063
MOSQUITOES AS VECTORS OF LIVESTOCK DISEASES ...4.0065
RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070
ASSESSMENT OF THE IMPORTANCE OF FILARIASIS IN THAILAND ...4.0072
CALIFORNIA ENCEPHALITIS VIRUS IN WISCONSIN ...4.0075

Anopheles

BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...2.0006
STUDIES ON INSECTICIDE RESISTANCE IN MOSQUITOES ...2.0017
INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025
BIOLOGICAL CONTROL OF INSECTS AFFECTING MAN ...2.0027
GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...2.0034
POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038
BIOLOGY AND WATER MANAGEMENT STUDIES FOR CONTROL OF LOUISIANA MOSQUITOES (RICE FIELDS) ...2.0044
STUDIES ON SOME FUNGAL PARASITES OF MOSQUITOES ...2.0072
MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085
MOSQUITOES OF MIDDLE AMERICA ...4.0037
ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...4.0039
BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN ...4.0047
BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...4.0058
BIONOMICS OF MARYLAND MOSQUITOES ...4.0063
MOSQUITOES AS VECTORS OF LIVESTOCK DISEASES ...4.0065

Anthomyiidae

EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...2.0002
ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

Calliphoridae

INSECTS AFFECTING MAN ...2.0068

Cecidomyiidae

STUDY OF CHRONIC TOXICITY OF LINDANE TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0337

Ceratopogonidae

INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...2.0029
BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057
INSECTS AFFECTING MAN AND ANIMALS ...2.0081
INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087
OCCURRENCE AND BIONOMICS OF BLOODSUCKING MIDGES (DIPTERA: CERATOPOGONIDAE) IN IOWA ...4.0056

Chironomidae

STUDY OF CHRONIC TOXICITY OF PARATHION TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0357
BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES ...2.0014
BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS ...2.0054
NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188

Chloropidae

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS ...2.0653
INSECTS AFFECTING MAN AND ANIMALS ...2.0081
A STUDY IN INSECT TRANSMISSION OF ANAPLASMOSIS ...4.0064

Culex

BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...2.0006
BIOLOGY AND CONTROL OF PASTURE MOSQUITOES ...2.0008
BIOLOGY AND CONTROL OF MOSQUITOES IN IRRIGATED AND WATER MANAGEMENT AREAS ...2.0011
SUPPLYING GENETIC MARKER AND INCOMPATIBLE STRAINS OF CULEX PIPIENS ...2.0012
CYTOPLASMIC INCOMPATIBILITY FOR FILARIASIS CONTROL ...2.0013
BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES ...2.0014
STUDIES ON INSECTICIDE RESISTANCE IN MOSQUITOES ...2.0017
SUPPRESSION AND ECOLOGY OF MOSQUITOES ...2.0018
IDENTIFICATION AND CHARACTERIZATION OF MOSQUITO PATHOGENS ...2.0020
INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025
INVESTIGATIONS OF THE ACTION OF CHEMOSTERILANTS ON HOUSEFLIES AND OTHER MEDICALLY IMPORTANT ARTHROPODS ...2.0026
INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...2.0029
CONTROL OF CULEX NIGRIPALPUS BY STERILITY METHODS ...2.0032
GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...2.0034
CYTOPLASMIC INHERITANCE AND CONTROL OF CULEX PIPIENS ...2.0041
BIOLOGY AND ECOLOGY OF SALT-MARSH MOSQUITOES OF LOUISIANA ...2.0042
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043
BIOLOGY AND WATER MANAGEMENT STUDIES FOR CONTROL OF LOUISIANA MOSQUITOES (RICE FIELDS) ...2.0044
GENETIC STUDIES ON THE CONTROL OF ARBOVIRUS VECTORS ...2.0048
MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...2.0062
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...2.0079
ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...2.0083
MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085
ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE ...4.0031
THE NUTRITION AND BEHAVIOR OF MOSQUITOES ...4.0033
FEEDING HABITS OF MOSQUITO LARVAE ...4.0034
DEVELOPMENT OF CULTURE METHODS FOR MOSQUITOES ...4.0035
CULTIVATION OF INSECT PHASE OF AVIAN PLASMODIA ...4.0036
ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...4.0039
ATTRACTIVENESS AND REPELLENCY OF MAN TO MOSQUITO BITES ...4.0041
ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046
POPULATION DYNAMICS OF MOSQUITOES IN FLORIDA ...4.0048
BIONOMICS OF SELECTED NORTH AMERICAN CULICINE MOSQUITOES ...4.0054
ARTHROPOD-BORNE VIRUS (ARBOVIRUS) ACTIVITY IN MAJOR MOSQUITO VECTORS IN IOWA ...4.0057
BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...4.0058
INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...4.0059
JAPANESE ENCEPHALITIS ON GUAM ...4.0062

Culicidae -other

FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL ...1.0077
CLASSIFICATION, BIONOMICS, ECOLOGY CONTROL OF FOREST INSECTS (OTHER THAN SCOLYTIDAE) IN CAL. ...1.0321
ECOLOGICAL STUDIES OF WILDLIFE MANAGEMENT PRACTICES ...1.0327
THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0330
STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970 ...1.0354
ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001
EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...2.0002
BIOLOGY OF PEST MOSQUITOES, AND CONTROL THROUGH COMMUNITY ACTION ...2.0004
CONTROL OF COMMON HOUSEFLY ...2.0005
TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...2.0007
AERIAL DISPERSAL METHODS FOR CONCENTRATED INSECTICIDES ...2.0009
INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...2.0010
BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES ...2.0014
EVALUATION OF NEW INSECTICIDES ...2.0015
NEW INSECTICIDES & TECHNIQUES FOR PEST CONTROL ...2.0016
INVESTIGATIONS OF PHEROMONES AS CHEMOSTERILANTS FOR INSECTS WITH SPECIAL REFERENCE TO SYNTHETIC QUEN SUBSTANCE AND ITS ANALOGUES ...2.0021
CULTIVATION OF COELOMOMYCES, A FUNGAL PARASITE OF MOSQUITOES ...2.0031
VIRAL PATHOGENS ...2.0035
FACTORS AFFECTING ROLE OF MICROORGANISMS IN BIOLOGICAL CONTROL OF INSECT PESTS ...2.0037
RELATION OF APPLICATION METHODS, CONCENTRATION, AND VOLUME OF INSECTICIDE TO CATTLE INSECT CONTROL ...2.0039
BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...2.0040
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043
EFFECT OF PREDATORS AND PARASITES ON MOSQUITO BREEDING IN LOUISIANA ...2.0045
INSECT CHEMOSTERILANTS ...2.0049
BIOLOGICAL EVALUATION OF INSECT CONTROL AGENTS ...2.0050
BIOLOGICAL AND BIOCHEMICAL FACTORS INFLUENCING THE DEVELOPMENT OF LARVAL MOSQUITO POPULATIONS ...2.0052
FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...2.0053
ABUNDANCE, DISTRIBUTION AND CONTROL OF MISCELLANEOUS INSECTS, AFFECTING LIVESTOCK ...2.0056
INSECT SURVEY OF MONTANA ...2.0058
SURVEY OF INSECT PROBLEMS IN MONTANA ...2.0059
COORDINATION OF MOSQUITO CONTROL IN NEW JERSEY ...2.0061
MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...2.0062
MOSQUITO CONTROL - TIDAL MARSHES ...2.0063
WATER MANAGEMENT IN MOSQUITO IMPOUNDMENTS ...2.0064
MOSQUITO CONTROL IN UPLAND SWAMPS ...2.0065
CONTROLLING MOSQUITOES ON HAYING MEADOWS ...2.0066
INSECTS AFFECTING MAN ...2.0068
LEGAL REPRESENTATION OF CITIZEN'S INTERESTS IN ENVIRONMENTAL PROTECTION ...2.0069

MODE OF ACTION OF A NEW FUNGAL PATHOGEN OF MOSQUITOES ...2.0070
POTENTIAL OF COELOMOMYCES FOR CONTROLLING MOSQUITOES ...2.0071
THE CONTROL OF MOSQUITOES OF MILITARY IMPORTANCE AND THE PREVENTION OF MOSQUITO-BORNE DISEASES ...2.0074
EMERGENCY INSECT CONTROL ...2.0076
NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077
THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078
INSECTS AFFECTING MAN AND ANIMALS ...2.0081
SUSCEPTIBILITY OR RESISTANCE OF MEDICALLY IMPORTANT INSECTS TO INSECTICIDES ON SELECTED AIR FORCE BASES ...2.0084
SELECTIVE TOXICITY BY OPTICALLY ACTIVE PHOSPHONOTHIONATE PESTICIDES ...2.0086
INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087
ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089
EFFECT OF BITING FLIES ON WEIGHT GAINS IN CATTLE ...2.0090
TRANSMISSION OF ANAPLASMOSIS ...4.0032
MOSQUITOES OF MIDDLE AMERICA ...4.0037
MOSQUITOES OF MIDDLE AMERICA ...4.0038
ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...4.0039
PUBLICATION OF BIBLIOGRAPHY OF MEDICAL ENTOMOLOGY ...4.0042
BIOLOGICAL STUDIES OF CULICOIDES AND THEIR CONTROL IN THE CANAL ZONE ...4.0043
BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...4.0045
ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046
COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...4.0049
MOSQUITOES OF THE NEW GUINEA AREA ...4.0050
DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...4.0051
MOSQUITOES OF MALAYSIA ...4.0060
BIONOMICS OF MARYLAND MOSQUITOES ...4.0063
A STUDY IN INSECT TRANSMISSION OF ANAPLASMOSIS ...4.0064
MOSQUITOES AS VECTORS OF LIVESTOCK DISEASES ...4.0065
INSECTS AS VECTORS OF DISEASES OF MILITARY IMPORTANCE IN ETHIOPIA THEIR ECOLOGY AND CONTROL ...4.0067
ENTOMOLOGY DEVELOPMENT OF A LIGHTWEIGHT TRAP FOR COLLECTION OF MOSQUITOES FOR VIRUS ISOLATION ...4.0071

Culiseta
BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...2.0006
MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...2.0060
ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...4.0039
BIONOMICS OF MARYLAND MOSQUITOES ...4.0063
PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA ...4.0074

Diptera -other
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...2.0079
AQUATIC & SEMI-AQUATIC DIPTERA STUDIES ...4.0073

Muscidae
ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001
CONTROL OF COMMON HOUSEFLY ...2.0005
EVALUATION OF NEW INSECTICIDES ...2.0015
INVESTIGATIONS OF THE ACTION OF CHEMOSTERILANTS ON HOUSEFLIES AND OTHER MEDICALLY IMPORTANT ARTHROPODS ...2.0026
INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...2.0029
INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...2.0030
RELATION OF APPLICATION METHODS, CONCENTRATION, AND VOLUME OF INSECTICIDE TO CATTLE INSECT CONTROL ...2.0039
BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...2.0040
BIOLOGICAL EVALUATION OF INSECT CONTROL AGENTS ...2.0050
BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057
INSECT SURVEY OF MONTANA ...2.0058
INSECTS AFFECTING MAN AND ANIMALS ...2.0081
MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085
INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087
EFFECT OF BITING FLIES ON WEIGHT GAINS IN CATTLE ...2.0090
TRANSMISSION OF ANAPLASMOSIS ...4.0032
BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN ...4.0047
DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053
A STUDY IN INSECT TRANSMISSION OF ANAPLASMOSIS ...4.0064

Oestridae
ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001
INSECTS AFFECTING MAN AND ANIMALS ...2.0081

Psychodidae
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS ...2.0033
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...2.0079
BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...4.0045

Sciomyzidae
BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...2.0269
BIOLOGICAL STUDIES OF MALACOPHAGOUS DIPTERA ...2.0282
EUROPEAN SCIOMYZIDAE ...2.0283
STUDY THE BIOLOGY OF A GROUP OF SNAIL-KILLING FLIES ...2.0287
AQUATIC & SEMI-AQUATIC DIPTERA STUDIES ...4.0073

Simuliidae
BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342
CONTROL OF BLACK FLIES AND MOSQUITOES IN MAINE ...2.0046
MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...2.0062
STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS ...2.0067
INSECTS AFFECTING MAN ...2.0068
INSECTS AFFECTING MAN AND ANIMALS ...2.0081
INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087
ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...4.0069

Syrphidae
EMERGENCY INSECT CONTROL ...2.0076

Tabanidae

ECOLOGICAL STUDIES OF WILDLIFE MANAGEMENT PRACTICES ...**1.0327**

ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...**2.0001**

DEVELOPMENT AND BEHAVIOR OF BITING DIPTERA ...**2.0023**

TESTING ADULT ATTRACTION DEVICES AND CHEMOSTERILANTS FOR TABANID FLY CONTROL ...**2.0024**

BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...**2.0040**

STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS ...**2.0067**

INSECTS AFFECTING MAN AND ANIMALS ...**2.0081**

EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...**2.0082**

INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...**2.0087**

ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...**4.0044**

A STUDY IN INSECT TRANSMISSION OF ANAPLASMOSIS ...**4.0064**

Tendipedidae

BIOLOGICAL FACTORS IN THE MANAGEMENT OF LAKE FLIES ...**2.0088**

Tephritidae

EMERGENCY INSECT CONTROL ...**2.0076**

Ephemeroptera

MAYFLY DISTRIBUTION AS A WATER QUALITY INDEX ...**1.0169**

BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...**1.0342**

STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970 ...**1.0354**

WATER QUALITY REQUIREMENTS OF AQUATIC INSECTS ...**4.0066**

Hemiptera

ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...**2.0001**

Lygaeidae

DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...**4.0053**

Homoptera

Aphididae

EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...**2.0002**

DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...**4.0053**

Hymenoptera

Apidae

MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...**1.0266**

AERIAL DISPERSAL METHODS FOR CONCENTRATED INSECTICIDES ...**2.0009**

Braconidae

BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...**2.0057**

Diprionidae

CLASSIFICATION, BIONOMICS, ECOLOGY CONTROL OF FOREST INSECTS (OTHER THAN SCOLYTIDAE) IN CAL. ...**1.0321**

Formicidae

EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...**2.0002**

SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...**2.0028**

BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...**2.0040**

Hymenoptera -other

BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES ...**2.0014**

Ichneumonidae

DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...**4.0053**

Insects -nonspecific

AN EVALUATION OF THE INSECTICIDE 'SEVIN' AS A WATERSHED POLLUTANT ...**1.0067**

ARTIFICIAL SUBSTRATE SAMPLERS AS INDICATORS OF WATER QUALITY ...**1.0225**

INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0351**

BIODEGRADATION OF PESTICIDES IN A FRESHWATER ECOSYSTEM - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0352**

NATURAL ENEMIES OF EURASIAN WATERMILFOIL IN PAKISTAN ...**2.0173**

METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...**2.0186**

LABORATORY ANALYSIS OF INSECTICIDE EFFECTIVENESS AGAINST MEDICALLY IMPORTANT INSECTS ...**4.0068**

Isoptera

ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...**2.0089**

Lepidoptera

Crambidae

SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...**2.0095**

Lepidoptera -other

CLASSIFICATION, BIONOMICS, ECOLOGY CONTROL OF FOREST INSECTS (OTHER THAN SCOLYTIDAE) IN CAL. ...**1.0321**

INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...**2.0144**

Lymantriidae

CLASSIFICATION, BIONOMICS, ECOLOGY CONTROL OF FOREST INSECTS (OTHER THAN SCOLYTIDAE) IN CAL. ...**1.0321**

Noctuidae

EFFECTS OF INSECTICIDES ON ACTIVITY OF SOIL INHABITING INSECTS ...**1.0059**

INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...**2.0030**

BIOLOGICAL EVALUATION OF INSECT CONTROL AGENTS ...**2.0050**

SURVEY OF INSECT PROBLEMS IN MONTANA ...**2.0059**

NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...**2.0135**

Phycitidae

EMERGENCY INSECT CONTROL ...**2.0076**

Pyralioidae

NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...**2.0135**

NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...**2.0188**

Pyraustidae

FACTORS AFFECTING ROLE OF MICROORGANISMS IN BIOLOGICAL CONTROL OF INSECT PESTS ...**2.0037**

INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...**2.0144**

INSECTS ASSOCIATED WITH AQUATIC WEED PESTS OF FOREIGN ORIGIN ...**2.0145**

DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...**4.0053**

Tortricidae

IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS ...1.0335

EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...2.0002

Mallophaga

ABUNDANCE, DISTRIBUTION AND CONTROL OF MISCELLANEOUS INSECTS, AFFECTING LIVESTOCK ...2.0056

Neuroptera

LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES ...1.0258

EMERGENCY INSECT CONTROL ...2.0076

Odonata

ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001

BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS ...2.0054

WATER QUALITY REQUIREMENTS OF AQUATIC INSECTS ...4.0066

Orthoptera

Acrididae

INSECT SURVEY OF MONTANA ...2.0058

SURVEY OF INSECT PROBLEMS IN MONTANA ...2.0059

SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...2.0095

Blattidae

MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...1.0266

EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...2.0002

BIOLOGICAL EVALUATION OF INSECT CONTROL AGENTS ...2.0050

SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...2.0055

SUSCEPTIBILITY OR RESISTANCE OF MEDICALLY IMPORTANT INSECTS TO INSECTICIDES ON SELECTED AIR FORCE BASES ...2.0084

DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...4.0051

Plecoptera

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039

LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES ...1.0258

WATER QUALITY REQUIREMENTS OF AQUATIC INSECTS ...4.0066

Siphonaptera

Pulicidae

NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077

Thysanoptera

EMERGENCY INSECT CONTROL MEASURES FOR ALASKA ...2.0002

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0129

Trichoptera

LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES ...1.0258

WATER QUALITY REQUIREMENTS OF AQUATIC INSECTS ...4.0066

Integrated Control

COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...1.0249

BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...2.0006

INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...2.0010

BIOLOGY AND CONTROL OF MOSQUITOES IN IRRIGATED AND WATER MANAGEMENT AREAS ...2.0011

MALARIA ERADICATION RESEARCH ...2.0051

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104

ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0117

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0129

AQUATIC WEED SUPPRESSION AND CONTROL IN LARGE CANALS ...2.0132

AQUATIC PLANT CONTROL - EQUIPMENT FOR MECHANICAL AND CHEMICAL DESTRUCTION ...2.0147

CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...2.0154

WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...2.0179

INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...2.0280

Interaction With Drugs

FACTORS AFFECTING PESTICIDE TOXICITY ...1.0255

Interaction With Environment

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0009

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013

VOLATILIZATION LOSSES OF PESTICIDES FROM SOILS ...1.0016

REACTIONS OF PESTICIDES WITH SOILS ...1.0020

REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...1.0021

MOVEMENT OF HERBICIDES IN SOIL BY MASS FLOW ...1.0044

WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...1.0050

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061

FATE OF PESTICIDES ...1.0064

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0091

FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105

FATE OF INSECTICIDES IN SOIL AND THEIR MOVEMENT IN WATER AND CROPS ...1.0111

A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0168

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0228

EFFECTS OF PESTICIDES ON AQUATIC ANIMALS IN THE ESTUARINE AND MARINE ENVIRONMENTS ...1.0234

RESEARCH STUDY ON THE EFFECTS OF POLLUTION ON SUB-TROPICAL FISH AND CRUSTACEANS ...1.0237

FACTORS AFFECTING PESTICIDE TOXICITY ...1.0255

THE INFLUENCES OF ENVIRONMENTAL CONDITIONS ON THE TOXICITY OF PESTICIDES ...1.0278

AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...1.0343

BIOLOGY AND CONTROL OF PASTURE MOSQUITOES ...2.0008

WEED CONTROL IN RICE PRODUCTION ...**2.0097**

LABORATORY STUDY OF AQUATIC ENVIRONMENTAL FACTORS AND PLANT GROWTH STAGES ON AQUATIC WEED GROWTH AND HERBICIDAL RESPONSE ...**2.0111**

BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0115**

EXPANDED AQUATIC PLANT CONTROL PROJECT ...**2.0146**

INFLUENCE OF PESTICIDES & OTHER HYDROCARBONS ON GROWTH OF EURYTOLERANT MICROALGAE ...**2.0148**

CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...**2.0154**

CONTROL OF CANADA THISTLE AND WATER WEEDS ...**2.0158**

INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...**2.0167**

METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...**2.0186**

BIOLOGY OF THE LARVAL SEA LAMPREY ...**2.0210**

BIOASSAY ...**2.0211**

THE TOXICITY AND DETOXIFICATION OF THE ROTENONE FORMULATIONS USED IN FISH MANAGEMENT ...**2.0226**

THE EFFICACY AND PERSISTENCE OF FORMULATIONS OF ANTIMYCIN ...**2.0244**

STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES ...**2.0256**

THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...**2.0261**

BIOLOGY AND CONTROL OF TERRESTRIAL MOLLUSCS ...**2.0281**

OYSTER DRIL (OCINEBRA JAPONICA) CONTROL ...**2.0293**

THE CONTROL OF SLUGS ...**2.0294**

Interaction With Fertilizers

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...**1.0008**

TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...**1.0056**

NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...**1.0073**

EVALUATION AND DEMONSTRATION OF IRRIGATION METHODS AND PRACTICES TO REDUCE CONTAMINATION IN IRRIGATION WASTE WATER ...**1.0104**

AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...**1.0186**

International Biol. Program

LAKE HURON CHEMICAL CONTROL ...**2.0209**

BIOLOGICAL STUDIES OF MALACOPHAGOUS DIPTERA ...**2.0282**

SHELLFISH MORTALITY - CHESAPEAKE BAY ...**3.0033**

PACIFIC OYSTER MORTALITY STUDIES ...**3.0034**

PATHOLOGY - EPIZOOTIOLOGY ...**3.0113**

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...**4.0018**

INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...**4.0059**

Invertebrate Anatomy

BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS ...**2.0054**

Invertebrate Nutrition

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...**1.0236**

ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...**1.0326**

BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...**2.0269**

Invertebrate Pathology

TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...**2.0007**

SCHISTOSOME CONTROL BY TREMATODE ANTAGONISM ...**2.0270**

BIOLOGY AND BIOLOGICAL CONTROL OF SCHISTOSOMIASIS ...**2.0277**

OYSTER DISEASE MORTALITY ALONG THE CALIFORNIA COAST ...**3.0022**

PATHOLOGY RESEARCH ...**3.0027**

MOLLUSCAN MORTALITY STUDIES ...**3.0032**

PACIFIC OYSTER MORTALITY STUDIES ...**3.0034**

MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...**3.0060**

ACQUIRED VS. GENETIC RESISTANCE IN OYSTERS ...**3.0078**

TESTS OF SELECTED SEED OYSTER STOCKS ON COMMERCIAL BEDS ...**3.0079**

PATHOLOGY - EPIZOOTIOLOGY ...**3.0113**

Invertebrate Physiology

Behavior -invertebrate

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...**1.0236**

NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...**2.0271**

OYSTER DRIL (OCINEBRA JAPONICA) CONTROL ...**2.0293**

Biological Rhythms

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...**1.0236**

EFFECTS OF PESTICIDES ON MARINE ANIMALS ...**1.0244**

CONTINUOUS-FLOW BIOASSAY OF PESTICIDES TO EVALUATE THE ACUTE AND CHRONIC EFFECTS OF PESTICIDES TO FRESHWATER INVERTEBRATES ...**1.0294**

Environmental Physiology

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...**1.0236**

MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...**2.0124**

Metabolism -invertebrate

CHEMICAL ANALYSES ...**1.0129**

ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...**1.0239**

PHYSIOLOGY OF ESTUARINE ORGANISMS ...**1.0242**

EFFECTS OF PESTICIDES ON MARINE ANIMALS ...**1.0244**

SEASONAL CHANGES IN ESTERASE ACTIVITY IN FISH AND INVERTEBRATES. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...**1.0275**

THE UPTAKE OF DIELDRIN IN THE THREE RIDGED NAIAD, AMBLEMA PLICATA ...**1.0301**

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...**1.0305**

INFLUENCE OF PROTOZOAN ACTIVITY ON HALOGENATED HYDROCARBON RESIDUES - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0349**

STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970 ...**1.0354**

BIOLOGY AND BIOLOGICAL CONTROL OF SCHISTOSOMIASIS ...**2.0277**

MOLLUSCICIDES - A CORRELATION OF STRUCTURE VS. ACTIVITY ...**2.0291**

Nervous System -invertebrate

ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...**1.0239**

Osmoregulation

AQUICULTURE, OYSTER HATCHERIES - RESEARCH ...**3.0118**

Reproductive System

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...**1.0236**

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0304

STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970 ...1.0354

MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...2.0124

BIOLOGY AND CONTROL OF TERRESTRIAL MOLLUSCS ...2.0281

OYSTER DRIL (OCINEBRA JAPONICA) CONTROL ...2.0293

USE OF CELL CULTURE METHODS TO ATTEMPT TO FOLLOW DEVELOPING STAGES OF SPORES ...3.0062

USE OF TISSUE SECTIONING TECHNIQUES TO ATTEMPT TO FOLLOW THE LIFE HISTORY OF WHIRLING DISEASE PARASITES FROM THE FIRST DAY OF INFECTION ...3.0065

TREATMENT OF WHIRLING DISEASE SPORES TO PRODUCE INFECTIVE STATES OF THE ORGANISM ...3.0066

ISOLATION AND FURTHER DESCRIPTION OF THE SPORES OF MYXOSOMA CEREBRALIS ...3.0101

REPRODUCTION & FUNGAL PARASITES AFFECTING REPRODUCTION IN LOBSTER, HUMARUS AMERICANNA, & BLUE CRAB CALLINECTES SAPIDUS, IN N.C. WATERS ...3.0115

AQUICULTURE, OYSTER HATCHERIES - RESEARCH ...3.0118

Respiratory System

RESPIRATION RATES OF FISH-FOOD INVERTEBRATES EXPOSED TO PESTICIDES ...1.0355

Sensory Organs -invertebrate

BEHAVIOR OF ESTUARINE ANIMALS ...1.0240

Serological Studies

EPIZOOTIOLOGY OF PARASITIC DISEASES IN FISH POPULATIONS UNDER INTENSIVE MANAGEMENT ...3.0001

Tissues -invertebrate

PHYSIOLOGY OF ESTUARINE ORGANISMS ...1.0242

CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER ...2.0290

Invertebrates -nonspecific

RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...1.0057

GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152

PESTICIDES RESEARCH ...1.0232

SEASONAL CHANGES IN ESTERASE ACTIVITY IN FISH AND INVERTEBRATES. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...1.0275

EFFECTS OF PARATHION AND MALATHION ON WARM-WATER FISH PONDS ...1.0283

CONTINUOUS-FLOW BIOASSAY OF PESTICIDES TO EVALUATE THE ACUTE AND CHRONIC EFFECTS OF PESTICIDES TO FRESHWATER INVERTEBRATES ...1.0294

PESTICIDE TOXICITY TO MARINE FISH AND INVERTEBRATES ...1.0307

ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...1.0339

SELECTED PESTICIDES IN AQUATIC FUNGI IN THE THREE RIVERS AREA ...1.0345

IN VITRO POTENCY OF SEVERAL ANTICHOLINESTERASE AGENTS WITH SELECTED MEMBERS OF THE AQUATIC ENVIRONMENT ...1.0348

POND ECOLOGY AND PRODUCTION AS AFFECTED BY SIMAZINE ...1.0353

RESPIRATION RATES OF FISH-FOOD INVERTEBRATES EXPOSED TO PESTICIDES ...1.0355

THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...1.0359

SELECTIVE TOXICITY BY OPTICALLY ACTIVE PHOSPHONOTHIONATE PESTICIDES ...2.0086

EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...2.0170

BIOASSAY ...2.0211

PATHOLOGY RESEARCH ...3.0027

SHELLFISH MORTALITY - CHESAPEAKE BAY ...3.0033

WALLEYE AND NORTHERN PIKE STUDY ...3.0072

TESTING OF STOCKS OF OYSTERS FOR DISEASE RESISTANCE ...3.0077

TESTS OF SELECTED SEED OYSTER STOCKS ON COMMERCIAL BEDS ...3.0079

Ion Exchange

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0141

ADSORPTION OF PESTICIDES FROM SEA WATER ...1.0159

Iowa

LIMNOLOGICAL FACTORS AFFECTING PESTICIDE RESIDUES IN SURFACE WATERS ...1.0149

EUTROPHICATION OF IOWA LAKES AND STREAMS ...4.0008

Irrigation

SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...1.0066

SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072

QUALITY OF IRRIGATION RETURN FLOW ...1.0102

PREDICTING MINERAL QUALITY OF RETURN FLOW WATER ...1.0122

COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...1.0125

INVESTIGATION OF RICE IRRIGATION RETURN FLOWS - TEXAS COASTAL PRAIRIE REGION ...1.0209

OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...1.0219

BIOLOGY AND CONTROL OF MOSQUITOES IN IRRIGATED AND WATER MANAGEMENT AREAS ...2.0011

INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106

HERBICIDE RESIDUES ...2.0109

INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...4.0059

Flood Irrigation

INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015

Furrow Irrigation

EVALUATION AND DEMONSTRATION OF IRRIGATION METHODS AND PRACTICES TO REDUCE CONTAMINATION IN IRRIGATION WASTE WATER ...1.0104

HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...1.0107

STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...2.0159

WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...2.0179

Sprinkler Irrigation

INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015

EVALUATION AND DEMONSTRATION OF IRRIGATION METHODS AND PRACTICES TO REDUCE CONTAMINATION IN IRRIGATION WASTE WATER ...1.0104

HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...1.0107

WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...2.0179

Isotopes

Radioactive Isotopes

Carbon

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0006

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008

MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS ...1.0011

HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...1.0035

FATE OF INSECTICIDES IN SOIL AND THEIR MOVEMENT IN WATER AND CROPS ...1.0111

PHYSIOLOGY OF ESTUARINE ORGANISMS ...1.0242

UPTAKE AND METABOLISM BY FISH OF 2,4-D DIMETHYL AMINE SALT ...1.0293

DEVELOPMENT OF TECHNIQUES FOR IDENTIFICATION OF PESTICIDES AND THEIR METABOLITES BY MASS SPECTROMETRY ...1.0295

Chlorine

THE CYCLING OF CL-36 LABELED DDT IN NATURAL ECOSYSTEMS ...1.0078

PREPARATION OF CHLORINE-36 LABELED ORGANOCHLORINE PESTICIDES AND RELATED COMPOUNDS (PCB'S) ...1.0174

Chromium

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260

Hydrogen

CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025

MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS ...1.0028

CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS ...2.0265

Iodine

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260

THYROIDAL I125 UPTAKE IN IMMATURE CHANNEL CATFISH FOLLOWING EXPOSURE TO SELECTED TOXICANTS ...1.0272

Lead

IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD ...1.0123

Phosphorus

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0192

FARM FISH POND MANAGEMENT ...1.0340

MOLLUSCICIDES - A CORRELATION OF STRUCTURE VS. ACTIVITY ...2.0291

A PROPOSAL TO STUDY PHOSPHATE INDUCED ALGAL GROWTH IN ORDER TO SUPPRESS OR ELIMINATE THIS PHENOMENA ...4.0021

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024

Radioisotopes -nonspecific

PESTICIDE RESIDUES ON ARIZONA CROPS ...1.0007

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0009

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019

MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS ...1.0028

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065

RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146

DEVELOPMENT OF ANALYTICAL METHODS FOR SELECTED HERBICIDES ...1.0175

IMPROVING WATER QUALITY BY REMOVAL OF PESTICIDE POLLUTANTS WITH AQUATIC PLANTS ...1.0216

THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0330

DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...1.0333

INTERCEPTION AND DEGRADATION OF PESTICIDES BY AQUATIC ALGAE ...1.0363

Sodium

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260

Italy

POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038

Jamaica

MOSQUITOES OF MIDDLE AMERICA ...4.0037

Japan

MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082

BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...4.0058

Kansas

POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078

Kaolin

FEEDING HABITS OF MOSQUITO LARVAE ...4.0034

Kenya

INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...4.0059

Lactic Acid

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269

SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...2.0028

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043

THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...2.0252

THE EFFECTS OF THANITE ON THE ACID-BASE BALANCE IN THE BLOOD OF FISHES ...2.0254

EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH ...2.0260

(U) REPELLENCY AND ATTRACTIVENESS OF MAN TO MOSQUITO BITES ...4.0040

Lake Champlain

PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN ...1.0213

Lakes

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...1.0143

RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146
THE FACTOR CONTROLLING THE DYNAMICS OF NON-IONIC SYNTHETIC ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS ...1.0148
MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...1.0160
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0192
FISHERIES UNIT ...1.0203
CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...1.0205
PESTICIDE LEVELS IN WATER AND WILDLIFE OF REELFOOT LAKE, TENNESSEE ...1.0208
EVALUATION OF PESTICIDE SOURCES AND LEVELS TRIBUTARY TO LAKES MICHIGAN AND SUPERIOR ...1.0221
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0223
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0224
THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...1.0297
PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...1.0328
DETERMINATION OF DIGESTION RATES FOR TROUT ...1.0346
EVALUATION OF GIZZARD SHAD AS A FORAGE FISH ...1.0356
PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...1.0358
THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...1.0359
CHEMICAL BIOCIDES IN LAKES ...1.0364
PESTICIDE LEVELS IN BIRDS WINTERING ON LAKE MICHIGAN ...1.0367
BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...2.0006
BIOLOGICAL FACTORS IN THE MANAGEMENT OF LAKE FLIES ...2.0088
FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...2.0142
INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...2.0144
ALGAE CONTROL BY ARTIFICIAL MIXING IN LAKE COCHITUATE ...2.0149
CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...2.0154
CONTROL OF EURASIAN MILFOIL ...2.0156
CONTROL AND UTILIZATION OF AQUATIC PLANTS ...2.0157
INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...2.0167
EUTROPHICATION - PILOT OPERATIONS ...2.0172
THE CRAYFISH (ORCONECTES CAUSEYI) AS A BIOLOGICAL CONTROL OF AQUATIC VEGETATION ...2.0175
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...2.0178
IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...2.0181
CHANGES IN WATER ENVIRONMENT RESULTING FROM AQUATIC PLANT CONTROL ...2.0183
SMALL IMPOUNDMENT STOCKING ...2.0190
HAUL SEINE STUDY ...2.0192
STRIPED BASS STUDIES ...2.0193
STUDY OF THE SEA LAMPREY IN LOVE LAKE ...2.0200
ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202
EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP, SOFT-WATER LAKES ...2.0213
EXPERIMENTAL ESTABLISHMENT OF MONOSPECIFIC WALLEYE POPULATIONS AS A MANAGEMENT MEASURE FOR SMALL WARMWATER LAKES IN NORTHERN MINNESOTA ...2.0214
THE INTERACTION OF THE WALLEYE AND WHITE SUCKER IN THE FISH POPULATION OF SOFT WATER LAKE IN NORTHEASTERN MINNESOTA ...2.0215
EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP SOFTWATER LAKES ...2.0216
RELATION OF LAMPREY EELS TO EXISTING SALMONID STOCKS IN CAYUGA LAKE ...2.0219
PISCICIDE TOXICOLOGY OF THE CYPRINIDS IN EAST AND WEST PAULINA LAKES ...2.0228
EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT) ...2.0229
EVALUATE FISH TOXICANT (ANTIMYCIN) (EAGLE LAKE SEGMENT) ...2.0230
MERIDIAN STATE PARK LAKE CRAPPIE REMOVAL EXPERIMENT ...2.0231
THE EFFICACY OF NEW FORMULATIONS OF ANTIMYCIN IN NATURAL LAKES AND STREAMS ...2.0246
SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...2.0278
REFINEMENT OF MANAGEMENT TECHNIQUES FOR STREAM TROUT LAKES ...3.0035
EXPERIMENTAL CONTROL OF NEASCUS IN SMALL TROUT LAKES ...3.0036
PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...3.0047
INFECTIOUS DISEASES OF SALMONID FISHES ...3.0049
BIOLOGY OF THE PROTOZOAN PARASITE CERATOMYXA SHASTA ...3.0050
IMPACT OF CERATOMYXA IN CENTRAL OREGON SALMONID POPULATIONS ...3.0057
TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005
RELATIVE LEACHING RATES OF COMMON NITROGEN CARRIERS FROM SANDY SOILS IN RELATION TO LAKE EUTROPHICATION ...4.0006
LAKE SUPERIOR PERIPHYTON IN RELATION TO WATER QUALITY ...4.0017
TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ...4.0030
POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078
A STUDY OF THE INTERACTION OF THREE SPECIES OF BULLHEAD AND ASSOCIATED GAME FISH SPECIES IN A SINGLE LAKE ...4.0079
REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES ...4.0083
SURVEYS FOR PANFISH CONTROL STUDIES ...4.0086

Eutrophic Lakes
NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0027
NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029
DETERMINATION OF THE EFFECTS OF A FERTILIZER-INDUCED PLANKTON TURBIDITY, SUPPLEMENTED BY HERBICIDES, ON SUBMERGED AQUATIC PLANTS ...2.0137
EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168
EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...2.0171
LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...2.0184
EUTROPHICATION OF IOWA LAKES AND STREAMS ...4.0008
AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...4.0011
NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...4.0015
PHYTOPLANKTON NUTRITION AND PHOTOSYNTHESIS IN EUTROPHIC LAKES ...4.0016

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...4.0018

RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...4.0019

STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...4.0022

NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE ...4.0025

Oligotrophic Lakes

EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029

Land Use

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161

WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...1.0162

AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...1.0186

QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187

QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204

REPRODUCTIVE PERFORMANCE OF FISH-EATING BIRDS IN NORTHERN CALIFORNIA ...1.0320

MOSQUITO CONTROL - TIDAL MARSHES ...2.0063

EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...2.0075

FOREST AND FARM GAME HABITAT; FISH POND ...2.0143

INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...4.0059

RENOVATION OF TROUT STREAMS ...4.0076

Larvicides

PESTICIDES AND WILDLIFE ...1.0324

INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025

BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057

MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...2.0062

SEA LAMPREY CONTROL - LAKE MICHIGAN CHEMICAL CONTROL ...2.0203

SEA LAMPREY CONTROL - LAKE HURON CHEMICAL CONTROL ...2.0204

LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...2.0205

SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...2.0206

SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...2.0207

SEA LAMPREY CONTROL - ASSESSMENT METHODS ...2.0208

LAKE HURON CHEMICAL CONTROL ...2.0209

BIOASSAY ...2.0211

FEEDING HABITS OF MOSQUITO LARVAE ...4.0034

Lasers and Masers

DETECTION AND IDENTIFICATION OF MOLECULAR WATER POLLUTANTS BY LASER RAMAN SPECTROSCOPY ...1.0151

CONTROL OF AQUATIC WEEDS BY USE OF N2-CO2-HE LASER SYSTEMS ...2.0091

Latex

FEEDING HABITS OF MOSQUITO LARVAE ...4.0034

Latitude

PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA ...4.0074

Leaching

LEACHING OF SELECTED HERBICIDES IN ALABAMA SOILS ...1.0001

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0002

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0006

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0009

SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL ...1.0012

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019

NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0027

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034

MOVEMENT OF HERBICIDES IN SOIL BY MASS FLOW ...1.0044

CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...1.0051

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053

PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS ...1.0055

ANALYSIS OF PESTICIDE RESIDUES ...1.0058

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065

SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...1.0066

SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072

FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL ...1.0077

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0084

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0097

MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...1.0098

EFFECT OF PESTICIDES ON THE QUALITY OF SURFACE AND GROUND WATERS IN THE WESTERN GULF REGION ...1.0101

EVALUATION AND DEMONSTRATION OF IRRIGATION METHODS AND PRACTICES TO REDUCE CONTAMINATION IN IRRIGATION WASTE WATER ...1.0104

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0141

LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION ...1.0178

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0192

OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...1.0219

RELATIVE LEACHING RATES OF COMMON NITROGEN CARRIERS FROM SANDY SOILS IN RELATION TO LAKE EUTROPHICATION ...4.0006

Legal Aspects

EVALUATION OF PESTICIDE SOURCES AND LEVELS TRIBUTARY TO LAKES MICHIGAN AND SUPERIOR ...1.0221

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029

Court Action

- LEGAL REPRESENTATION OF CITIZEN'S INTERESTS IN ENVIRONMENTAL PROTECTION ...2.0069

Eminent Domain

- ILLINOIS LAWS AFFECTING AGRICULTURE ...1.0332

Legislation

- ILLINOIS LAWS AFFECTING AGRICULTURE ...1.0332
- HERBICIDE RESIDUES ...2.0109

Standards

- REDUCTION OF PESTICIDE RESIDUE HAZARDS ...1.0040
- PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...1.0075
- PESTICIDE TESTING FOR SETTING STANDARDS ...1.0165
- DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...1.0333
- HERBICIDE RESIDUES ...2.0109
- THE TOXICITY AND DRUG RESIDUE LEVEL OF CHLORAMPHENICOL IN TREATED RAINBOW TROUT ...3.0133

Light -general

- RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019
- CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191
- INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087
- LABORATORY STUDY OF AQUATIC ENVIRONMENTAL FACTORS AND PLANT GROWTH STAGES ON AQUATIC WEED GROWTH AND HERBICIDAL RESPONSE ...2.0111
- BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115
- BIOLOGY AND CONTROL OF TERRESTRIAL MOLLUSCS ...2.0281
- ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...4.0039
- BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN ...4.0047
- A STUDY IN INSECT TRANSMISSION OF ANAPLASMOSIS ...4.0064

Light Quality

- AQUATIC WEED CONTROL RESEARCH ...2.0100
- WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104
- INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...2.0167

Blue Light

- INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087

Far Red Light

- FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS ...2.0141
- LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010

Infra Red Light

- INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087

Red Light

- FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS ...2.0141
- LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010

Ultraviolet Light

- INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...2.0030
- INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087

Yellow Light

- INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087

Light Quantity or Intensity

- FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095
- AQUATIC WEED CONTROL RESEARCH ...2.0100
- WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104
- FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS ...2.0141
- NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180

Darkness

- MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...1.0266
- INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...2.0030
- SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...2.0055
- A STUDY IN INSECT TRANSMISSION OF ANAPLASMOSIS ...4.0064

Lime

- POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078

Literature Search

- CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0093
- DEVELOPMENT OF ANALYTICAL METHODS FOR SELECTED HERBICIDES ...1.0175
- PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...1.0199
- CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0210
- RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...2.0161
- EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...2.0170
- BIOLOGY AND CONTROL OF TERRESTIAL MOLLUSKS ...2.0289
- IDENTIFICATION OF PARASITES AND DISEASES EFFECTING MARICULTURE SPECIES ...3.0037
- MARINE FISH-CULTURE PATHOLOGY ...3.0070
- A PROPOSAL TO STUDY PHOSPHATE INDUCED ALGAL GROWTH IN ORDER TO SUPPRESS OR ELIMINATE THIS PHENOMENA ...4.0021

Louisiana

- GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152
- INSECTS ASSOCIATED WITH AQUATIC WEED PESTS OF FOREIGN ORIGIN ...2.0145
- UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029
- IDENTIFICATION OF PARASITES AND DISEASES EFFECTING MARICULTURE SPECIES ...3.0037

Luciferin

- THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM ...1.0350

Lysimeters

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065
SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...1.0066
ENVIRONMENTAL BIOLOGY - BIOGEOCHEMICAL CYCLING IN ECOLOGICAL SYSTEMS ...1.0068

Magnetic Fields -bioeffects

ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...4.0007

Malaysia - Malaya

MOSQUITOES OF MALAYSIA ...4.0060

Mammal Studies

Censusing

FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...2.0142

Control of Nuisance Species

CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...1.0235
EVALUATION OF WATERFOWL PREDATOR CONTROL METHODS ...2.0272

Food Supply

FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...2.0142

Mark, Tag or Capture

ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...2.0083

Pathology

DIAGNOSIS OF DISEASES IN WILDLIFE ...3.0134

Manometers

COMPARISON OF METHODS USED TO MEASURE ESTERASE ACTIVITY INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...1.0274

Mariana Islands

JAPANESE ENCEPHALITIS ON GUAM ...4.0062

Marine Biology

PESTICIDE KINETICS ...1.0127
CHEMICAL ANALYSES ...1.0129
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0140
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0158
SERVICES FOR THE QUANTITATIVE ANALYSIS OF PESTICIDES IN SEAWATER AND BIOLOGICAL SAMPLES ...1.0172
LABORATORY BIOASSAYS ...1.0241
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0305
MARINE PILING ANALYSIS ...2.0296
IDENTIFICATION OF PARASITES AND DISEASES EFFECTING MARICULTURE SPECIES ...3.0037
RESEARCH VESSEL OPERATIONS ...3.0048

Marine Animals

A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0140
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0158
RESEARCH STUDY ON THE EFFECTS OF POLLUTION ON SUB-TROPICAL FISH AND CRUSTACEANS ...1.0237
PESTICIDE MONITORING PROGRAM ...1.0238
ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...1.0239
BEHAVIOR OF ESTUARINE ANIMALS ...1.0240
LABORATORY BIOASSAYS ...1.0241
PHYSIOLOGY OF ESTUARINE ORGANISMS ...1.0242
EFFECTS OF PESTICIDES ON MARINE ANIMALS ...1.0244
PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES ...1.0254
ACCUMULATION OF PESTICIDES IN MENHADEN ...1.0299
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0304
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0305
PESTICIDE TOXICITY TO MARINE FISH AND INVERTEBRATES ...1.0307
PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...1.0358
STUDIES OF SHARK REPELLENTS AND OTHER ANTISHARK MEASURES ...2.0191
EFFECTS OF METHOXYCHLOR ON THE CONDITIONING OF STRIPED BASS TO AN OLFACTORY STIMULUS ...2.0233
EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...2.0267
'A METHOD OF DESTROYING ONCOMELANIA-THE SNAIL VECTOR OF SCHISTOSOMIASIS' ...2.0284
EFFECT OF PRETREATMENT MOLDING OF SOUTHERN PINE ON THE PERMANENCE OF THE PRESERVATIVE IN SEAWATER EXPOSURE ...2.0295
MARINE PILING ANALYSIS ...2.0296
OYSTER DISEASE MORTALITY ALONG THE CALIFORNIA COAST ...3.0022
PATHOLOGY RESEARCH ...3.0027
UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029
PACIFIC OYSTER MORTALITY STUDIES ...3.0034
IDENTIFICATION OF PARASITES AND DISEASES EFFECTING MARICULTURE SPECIES ...3.0037
RESEARCH VESSEL OPERATIONS ...3.0048
ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...3.0052
AQUICULTURE, SALMON CULTURE - RESEARCH ...3.0053
MARINE FISHERIES - SYMBIOSIS AND PARASITISM - RESEARCH ...3.0055
VIRAL DISEASES OF MARINE FISHES ...3.0061
MULTIPLICATION OF ENTERIC VIRUSES IN SHELLFISH ...3.0069
MARINE FISH-CULTURE PATHOLOGY ...3.0070
BACTERIAL AND VIRAL DISEASES AND CELL CULTURES OF MARINE FISH AND SHELLFISH ...3.0074
A HISTOLOGIC STUDY OF MARINE FISH ...3.0076
TESTS OF SELECTED SEED OYSTER STOCKS ON COMMERCIAL BEDS ...3.0079
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082
SPAWNING AND REARING OF MARINE FISH ...3.0110
AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...3.0126

Marine Plants

ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT ...1.0131
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...2.0075
UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029

AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...3.0126

Marine Fouling -see Corrosion

MARINE PILING ANALYSIS ...2.0296

Marine Geology

Ocean Sediments

ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120
RESEARCH VESSEL OPERATIONS ...3.0048

Sub-bottom Structure

GREEN BAY RESEARCH PROGRAM ...1.0112

Marine Pollution

ESTUARINE ECOSYSTEMS ...1.0128
EFFLUENT INFLUENCES OF THE MISSISSIPPI RIVER ON THE CHEMISTRY AND BIOLOGY OF ADJACENT OCEAN SYSTEMS ...1.0130
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0140
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0158
SERVICES FOR THE QUANTITATIVE ANALYSIS OF PESTICIDES IN SEAWATER AND BIOLOGICAL SAMPLES ...1.0172
BEHAVIOR OF ESTUARINE ANIMALS ...1.0240
LABORATORY BIOASSAYS ...1.0241
EFFECTS OF PESTICIDES ON MARINE ANIMALS ...1.0244

Maryland

PATHOLOGY - EPIZOOTIOLOGY ...3.0113
ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046

Massachusetts

MASSACHUSETTS PESTICIDE MONITORING STUDY ...1.0157

Mating Season

DEVELOPMENT OF CULTURE METHODS FOR MOSQUITOES ...4.0035

Mechanism of Transmission

ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...2.0083
ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046

Animal Reservoirs and Vectors

MALARIA ERADICATION RESEARCH ...2.0051
SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...2.0278
ARTHROPODS OF MEDICAL AND VETERINARY IMPORTANCE ...4.0031
JAPANESE ENCEPHALITIS ON GUAM ...4.0062
INSECTS AS VECTORS OF DISEASES OF MILITARY IMPORTANCE IN ETHIOPIA THEIR ECOLOGY AND CONTROL ...4.0067
ASSESSMENT OF THE IMPORTANCE OF FILARIASIS IN THAILAND ...4.0072
CALIFORNIA ENCEPHALITIS VIRUS IN WISCONSIN ...4.0075

Meetings

DESIGNING A GLOBAL ENVIRONMENTAL MONITORING SYSTEM ...1.0206
EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...2.0170

Metabolites From Pesticides

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019
PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...1.0033
REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0037
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0038
INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0043
REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0046
ANALYSIS OF PESTICIDE RESIDUES ...1.0058
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061
PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS ...1.0063
FATE OF PESTICIDES ...1.0064
THE CYCLING OF CL-36 LABELED DDT IN NATURAL ECOSYSTEMS ...1.0078
PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...1.0087
ANALYTICAL METHODS FOR PESTICIDES AND PESTICIDE DEGRADATION PRODUCTS ...1.0088
FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...1.0089
FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095
HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...1.0107
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0141
RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146
PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...1.0170
LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...1.0212
IMPROVING WATER QUALITY BY REMOVAL OF PESTICIDE POLLUTANTS WITH AQUATIC PLANTS ...1.0216
TERMINAL RESIDUES OF CHLORINATED HYDROCARBON PESTICIDES IN LAKE MICHIGAN AND ASSOCIATED TRIBUTARIES ...1.0222
RELATIONSHIPS BETWEEN SUB-LETHAL PESTICIDES AND REPRODUCTION AND BEHAVIOR OF FISHES ...1.0245
DEVELOPMENT OF TECHNIQUES FOR IDENTIFICATION OF PESTICIDES AND THEIR METABOLITES BY MASS SPECTROMETRY ...1.0295
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319
INVESTIGATION OF MEANS FOR CONTROLLED SELF-DESTRUCTION OF PESTICIDES ...1.0323
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0334
CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...2.0185

Metallic Alloys

INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106

Metals

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086

BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342

Boron

INSECT CHEMOSTERILANTS ...2.0049

Tin

INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106

Metals -general

Heavy Metals

A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0140

ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...1.0153

A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0158

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161

DEVELOP IN-HOUSE CAPABILITY IN WATER QUALITY TECHNIQUES FOR ANALYSES OF HEAVY METALS, BACTERIA, AND PESTICIDE RESIDUES ...1.0171

DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...1.0184

CENTER FOR STUDY OF THE HUMAN ENVIRONMENT ...1.0190

ENZYME AND TISSUE ALTERATIONS IN FISH - A MEASURE OF WATER QUALITY ...1.0248

BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...1.0303

Metals -nonspecific

FATE OF HARMFUL METALS IN SOIL AND WATER SYSTEMS ...1.0003

REACTIONS OF PESTICIDES WITH SOILS ...1.0020

IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD ...1.0123

ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...1.0153

MICROWAVE-EXCITED EMISSION DETECTOR FOR PESTICIDES AND TRACE METAL ANALYSIS ...1.0195

Salts

STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES ...1.0142

SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...1.0181

PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...1.0199

EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082

Trace Metals

CENTER FOR STUDY OF THE HUMAN ENVIRONMENT ...1.0190

MICROWAVE-EXCITED EMISSION DETECTOR FOR PESTICIDES AND TRACE METAL ANALYSIS ...1.0195

BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...1.0303

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174

Metals -transition

Chromium

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053

BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...1.0303

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174

Copper

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082

CENTER FOR STUDY OF THE HUMAN ENVIRONMENT ...1.0190

MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...1.0292

TOXICITY OF SELECTED METALS TO CONDITIONED FISH ...1.0302

EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...2.0116

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0129

Iron

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...1.0292

EVALUATION OF POND CONDITIONS FOLLOWING FERTILIZATION ...2.0153

THE EFFECTS OF THANITE ON THE INORGANIC BLOOD CHEMISTRIES OF FISHES ...2.0253

THE EFFECTS OF THANITE ON THE ACID-BASE BALANCE IN THE BLOOD OF FISHES ...2.0254

Manganese

MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...1.0292

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174

Nickel

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174

Vanadium

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174

Metals, B Sub-group

Aluminum

CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS ...1.0042

ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106

Cadmium

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053

TOXICITY OF SELECTED METALS TO CONDITIONED FISH ...1.0302

Lead

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053

IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD ...1.0123

CENTER FOR STUDY OF THE HUMAN ENVIRONMENT ...1.0190

Mercury

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086

IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD ...1.0123

PESTICIDE RESIDUES IN KANSAS STREAMS ...1.0150

CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...1.0235

Zinc

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053
MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...1.0292
TOXICITY OF SELECTED METALS TO CONDITIONED FISH ...1.0302
EFFECTS OF TOXICANTS UPON FISH MOVEMENT PATTERNS ...1.0308

Michigan

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161
ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202
SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...2.0206
SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...2.0279

Microorganisms -nonspecific

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0002
EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANO-TOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041
ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN ...1.0132
PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN .. 1.0213
TERMINAL RESIDUES OF CHLORINATED HYDROCARBON PESTICIDES IN LAKE MICHIGAN AND ASSOCIATED TRIBUTARIES ...1.0222
THE CHEMISTRY AND TOXICOLOGY OF AGRICULTURAL CHEMICALS ...1.0322
CONSTRUCTION OF PESTICIDES DEGRADABLE BY NORMAL MICROFLORA OF NATURAL WATERS AND SOILS ...1.0331
DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...1.0333
BIODEGRADATION OF PESTICIDES IN A FRESHWATER ECOSYSTEM - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0352
AQUATIC PEST CONTROL ...2.0112
ALLEVIATION OF LAKE POLLUTION BY UTILIZATION OF AQUATIC PLANTS FOR NUTRITIONAL, MEDICINAL OR INDUSTRIAL PURPOSES ...2.0152
PACIFIC OYSTER MORTALITY STUDIES ...3.0034
ETIOLOGY OF ESTUARINE FISH DISEASES ...3.0040
THE RELATIONSHIP OF TEMPERATURE TO DISEASE OF SALMONID FISHES ...3.0051
INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...4.0027

Mineral Composition

MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...1.0292
INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...4.0001

Mineral Content -water

PROPERTIES OF TILE DRAINAGE WATER ...1.0045
UPPER ST. JOHNS RIVER BASIN WATER QUALITY, FLORIDA ...1.0134
STATIC BIOASSAY OF TRACERS AND DYES AGAINST FISH AND INVERTEBRATES ...1.0316
AQUATIC WEED CONTROL RESEARCH ...2.0100
WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104
GROWTH REGULATORS AND MINERAL NUTRITION IN AQUATIC PLANT CONTROL ...2.0134
CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...2.0154
THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174
NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180
EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP SOFTWATER LAKES ...2.0216
THE EFFICACY AND PERSISTENCE OF FORMULATIONS OF ANTIMYCIN ...2.0244
STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0255
STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES ...2.0256
STATIC BIOASSAY OF COLLECTING AIDS AGAINST FISH ...2.0257
STATIC BIOASSAY OF ATTRACTANTS AND REPELLANTS AGAINST FISH AND INVERTEBRATES ...2.0258
THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...2.0261
PATHOLOGY OF AEROMONAS LIQUIFACIENS IN CHANNEL CATFISH ...3.0013
THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER ...4.0004
TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005
EUTROPHICATION OF IOWA LAKES AND STREAMS ...4.0008
AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...4.0011
BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...4.0012
THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0014
RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...4.0019
THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0020
A PROPOSAL TO STUDY PHOSPHATE INDUCED ALGAL GROWTH IN ORDER TO SUPPRESS OR ELIMINATE THIS PHENOMENA ...4.0021
EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...4.0023
ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024
NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE ...4.0025
TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ...4.0030

Minnesota

PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166
LAKE SUPERIOR COMMERCIAL FISHERIES ASSESSMENT STUDIES ...2.0212
EXPERIMENTAL ESTABLISHMENT OF MONOSPECIFIC WALLEYE POPULATIONS AS A MANAGEMENT MEASURE FOR SMALL WARMWATER LAKES IN NORTHERN MINNESOTA ...2.0214
NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...4.0015
PHYTOPLANKTON NUTRITION AND PHOTOSYNTHESIS IN EUTROPHIC LAKES ...4.0016

Mississippi

GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152

Mississippi River

EFFLUENT INFLUENCES OF THE MISSISSIPPI RIVER ON THE CHEMISTRY AND BIOLOGY OF ADJACENT OCEAN SYSTEMS ...**1.0130**

MAYFLY DISTRIBUTION AS A WATER QUALITY INDEX ...**1.0169**

PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...**1.0170**

IDENTIFICATION OF PARASITES AND DISEASES EFFECTING MARICULTURE SPECIES ...**3.0037**

Missouri

CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...**2.0154**

CONTROL OF EURASIAN MILFOIL ...**2.0156**

CONTROL AND UTILIZATION OF AQUATIC PLANTS ...**2.0157**

Mode of Action -animal

REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0046**

METABOLISM OF ENDRIN IN PONDS ...**1.0113**

RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...**1.0146**

A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...**1.0168**

EFFECT OF ENDRIN ON EGG-SPERM FORMATION AND EMBRYONIC DEVELOPMENT ...**1.0229**

EFFECT OF ENDRIN ON FISH AND THEIR ENVIRONMENT UNDER CONTROLLED CONDITIONS ...**1.0230**

PRELIMINARY STUDIES ON ENDRIN AND OTHER PESTICIDE UPTAKES BY FINGERLING CHANNEL CATFISH ...**1.0231**

EFFECTS OF PESTICIDES ON AQUATIC ANIMALS IN THE ESTUARINE AND MARINE ENVIRONMENTS ...**1.0234**

ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...**1.0239**

PHYSIOLOGY OF ESTUARINE ORGANISMS ...**1.0242**

EFFECTS OF PESTICIDES ON MARINE ANIMALS ...**1.0243**

EFFECTS OF PESTICIDES ON MARINE ANIMALS ...**1.0244**

CONTAMINATION OF CHANNEL CATFISH WITH DIELDRIN FROM AGRICULTURAL RUNOFF ...**1.0247**

EFFECTS OF CHRONIC SUBLETHAL DOSAGES OF DDT ON THE SWIMMING PERFORMANCE OF ATLANTIC SALMON PARR ...**1.0252**

PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES ...**1.0254**

FACTORS AFFECTING PESTICIDE TOXICITY ...**1.0255**

LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES ...**1.0258**

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...**1.0260**

BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH ...**1.0261**

STREAM STUDIES TO DETERMINE TOXIC EFFECTS OF METHOXYCHLOR IN FISH POPULATIONS ...**1.0263**

A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...**1.0265**

MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...**1.0266**

THE UPTAKE OF AND BIOLOGICAL RESPONSES TO AROCLORS IN CHANNEL CATFISH ...**1.0267**

SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA - CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...**1.0268**

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0269**

EFFECTS ON THE SPERMIATION RESPONSE OF GOLDFISH AFTER EXPOSURE TO SELECTED PESTICIDES ...**1.0270**

NERVE IMPULSE TRANSMISSION CHARACTERISTICS OF ISOLATED FISH-NERVE PREPARATIONS PERFUSED WITH PHYSIOLOGICAL LEVELS OF SELECTED PESTICIDES ...**1.0271**

THYROIDAL I125 UPTAKE IN IMMATURE CHANNEL CATFISH FOLLOWING EXPOSURE TO SELECTED TOXICANTS ...**1.0272**

SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0273**

COMPARISON OF METHODS USED TO MEASURE ESTERASE ACTIVITY. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...**1.0274**

SEASONAL CHANGES IN ESTERASE ACTIVITY IN FISH AND INVERTEBRATES. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...**1.0275**

CHARACTERIZATION OF ESTERASE(S) PRESENT IN FISH BLOOD ...**1.0276**

SCREENING OF PESTICIDES AGAINST FISH AT COLUMBIA MISSOURI ...**1.0277**

THE SUSCEPTIBILITY OF VARIOUS LIFE STAGES OF FRESHWATER FISHES TO THREE TOXICANTS ...**1.0279**

INVESTIGATION OF STRESS-INDUCED MOBILIZATION OF INSECTICIDE RESIDUES - CHRONIC TOXICITY OF PESTICIDES TO FISH ...**1.0281**

CHRONIC EFFECTS OF DURSBAN ON WARM-WATER FISH ...**1.0282**

EFFECTS OF PARATHION AND MALATHION ON WARM-WATER FISH PONDS ...**1.0283**

UPTAKE, PERSISTENCE AND METABOLITES OF SEVIN BY CHANNEL CATFISH ...**1.0284**

CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...**1.0285**

EARLY SQUAMATION OF BLUEGILL (LEPOMIS MACROCHIRUS) AND FATHEAD MINNOWS (PIMEPHALES PROMELAS) EXPOSED TO AROCLORS ...**1.0286**

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0288**

PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...**1.0289**

PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...**1.0290**

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0291**

MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...**1.0292**

CONTINUOUS-FLOW BIOASSAY OF PESTICIDES TO EVALUATE THE ACUTE AND CHRONIC EFFECTS OF PESTICIDES TO FRESHWATER INVERTEBRATES ...**1.0294**

METHOXYCHLOR-CAUSED EFFECTS ON CUTTHROAT TROUT PHYSIOLOGY - CHRONIC TOXICITY OF INSECTICIDES TO COLD-WATER FISH ...**1.0296**

ACCUMULATION OF PESTICIDES IN MENHADEN ...**1.0299**

TOXICITY OF SELECTED METALS TO CONDITIONED FISH ...**1.0302**

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...**1.0304**

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...**1.0305**

INHIBITORY EFFECT OF DDT IN ATPASE ASSAY MIXTURES ...**1.0309**

STATIC BIOASSAY OF TRACERS AND DYES AGAINST FISH AND INVERTEBRATES ...**1.0316**

FISHERY RESOURCES PROGRAM ...**1.0317**

THE CHEMISTRY AND TOXICOLOGY OF AGRICULTURAL CHEMICALS ...**1.0322**

CONSTRUCTION OF PESTICIDES DEGRADABLE BY NORMAL MICROFLORA OF NATURAL WATERS AND SOILS ...**1.0331**

EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS ...**1.0341**

IN VITRO POTENCY OF SEVERAL ANTICHOLINESTERASE AGENTS WITH SELECTED MEMBERS OF THE AQUATIC ENVIRONMENT ...**1.0348**

INFLUENCE OF PROTOZOAN ACTIVITY ON HALOGENATED HYDROCARBON RESIDUES - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0349**

POND ECOLOGY AND PRODUCTION AS AFFECTED BY SIMAZINE ...**1.0353**

STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970 ...**1.0354**

RESPIRATION RATES OF FISH-FOOD INVERTEBRATES EXPOSED TO PESTICIDES ...1.0355

TOXICOLOGY OF PESTICIDES IN THE ENVIRONMENT ...1.0360

PHARMACOLOGICAL AND ECOLOGICAL EFFECTS OF PESTICIDES ...1.0362

THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...1.0365

STUDY ON THE EFFECTS OF FISH TOXICANTS ANTIMYCIN A AND ROTENONE ON POND COMMUNITIES ...1.0366

INVESTIGATIONS OF PHEROMONES AS CHEMOSTERILANTS FOR INSECTS WITH SPECIAL REFERENCE TO SYNTHETIC QUEN SUBSTANCE AND ITS ANALOGUES ...2.0021

INSECT CHEMOSTERILANTS ...2.0049

SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...2.0055

NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077

THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078

ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089

CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104

SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...2.0206

EFFECTS OF METHOXYCHLOR ON THE CONDITIONING OF STRIPED BASS TO AN OLFACTORY STIMULUS ...2.0233

EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...2.0234

INTENSIVE SCREENING OF POTENTIAL FISH CONTROL AGENTS - POTENTIATION OF ANTIMYCIN ...2.0241

ROUTE(S) OF EXCRETION OF QUINALDINE SULFATE, A FISH ANESTHETIC ...2.0249

IN VIVO AND IN VITRO STUDIES ON THE MODE OF ACTION OF TFM ...2.0250

METABOLISM AND EXCRETION OF TFM ...2.0251

THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...2.0252

THE EFFECTS OF THANITE ON THE INORGANIC BLOOD CHEMISTRIES OF FISHES ...2.0253

THE EFFECTS OF THANITE ON THE ACID-BASE BALANCE IN THE BLOOD OF FISHES ...2.0254

STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0255

STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES ...2.0256

STATIC BIOASSAY OF COLLECTING AIDS AGAINST FISH ...2.0257

STATIC BIOASSAY OF ATTRACTANTS AND REPELLANTS AGAINST FISH AND INVERTEBRATES ...2.0258

CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0259

EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH ...2.0260

THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...2.0261

THE EFFECTS OF ANTIMYCIN A ON THE METABOLISM OF SELECTED TISSUES IN FISH (ABBREV) ...2.0262

CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER ...2.0290

MOLLUSCICIDES - A CORRELATION OF STRUCTURE VS. ACTIVITY ...2.0291

DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...4.0051

LABORATORY ANALYSIS OF INSECTICIDE EFFECTIVENESS AGAINST MEDICALLY IMPORTANT INSECTS ...4.0068

Mode of Action -plant

RESPROUTING OF CHAPARRAL ...1.0017

CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025

INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0043

FATE OF PESTICIDES ...1.0064

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082

COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145

RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146

DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...1.0196

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0228

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319

CONSTRUCTION OF PESTICIDES DEGRADABLE BY NORMAL MICROFLORA OF NATURAL WATERS AND SOILS ...1.0331

AN INVESTIGATION OF THE EFFECTS OF DDT AND OTHER CHLORINATED HYDROCARBONS ON THE GROWTH OF EURYHALINE MICROALGAE ...1.0336

POND ECOLOGY AND PRODUCTION AS AFFECTED BY SIMAZINE ...1.0353

TOXICOLOGY OF PESTICIDES IN THE ENVIRONMENT ...1.0360

ENVIRONMENTAL TOXICOLOGY OF PESTICIDES ...1.0361

GROWTH REGULATORS AND MINERAL NUTRITION IN AQUATIC PLANT CONTROL ...2.0134

EXPANDED AQUATIC PLANT CONTROL PROJECT ...2.0146

METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186

LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010

Models

Computer Models

PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...1.0094

Mathematical Models

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0006

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034

MOVEMENT OF HERBICIDES IN SOIL BY MASS FLOW ...1.0044

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0084

INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0116

AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117

ATTENTION AND RUNOFF OF PESTICIDES FROM AGRICULTURAL LANDS TO SURFACE WATERS ...1.0124

Models -other

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013

MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099

Physical Models

PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...1.0094

SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...1.0181

EUTROPHICATION - PILOT OPERATIONS ...2.0172

ALGACIDES FOR USE IN WATER RECLAMATION AND REUSE SYSTEMS ...2.0177

Mollusca

Clams

PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166
PRESTICIDE INPUTS AND LEVELS IN MINNESOTA WATERS OF THE LAKE SUPERIOR BASIN ...1.0167
PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...1.0236
PESTICIDE MONITORING PROGRAM ...1.0238
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0305
AQUATIC WEED CONTROL RESEARCH ...2.0100
CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101
WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104
MOLLUSCAN MORTALITY STUDIES ...3.0032
ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...3.0052

Gastropoda

OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...1.0219
THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0330
AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...1.0343
ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0117
MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...2.0124
METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186
CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266
BIOLOGY AND CONTROL OF SNAILS ...2.0268
BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...2.0269
SCHISTOSOME CONTROL BY TREMATODE ANTAGONISM ...2.0270
NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...2.0271
EXPERIMENTS TO RE-ESTABLISH HISTORICAL OYSTER SEED GROUNDS AND TO CONTROL THE SOUTHERN OYSTER DRILL ...2.0274
THE BIOLOGY AND CONTROL OF THE SNAIL INTERMEDIATE HOST OF SCHISTOSOMES ...2.0276
BIOLOGY AND BIOLOGICAL CONTROL OF SCHISTOSOMIASIS ...2.0277
SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...2.0278
SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...2.0279
INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...2.0280
BIOLOGY AND CONTROL OF TERRESTRIAL MOLLUSCS ...2.0281
BIOLOGICAL STUDIES OF MALACOPHAGOUS DIPTERA ...2.0282
EUROPEAN SCIOMYZIDAE ...2.0283
'A METHOD OF DESTROYING ONCOMELANIA-THE SNAIL VECTOR OF SCHISTOSOMIASIS' ...2.0284
METHOD OF KILLING ONCOMELANIA & AQUATIC SNAIL VECTORS OF SCHISTOSOMIASIS ...2.0285
DEVELOPMENT OF A TOXIC BAIT ...2.0286
STUDY THE BIOLOGY OF A GROUP OF SNAIL-KILLING FLIES ...2.0287
ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288
BIOLOGY AND CONTROL OF TERRESTIAL MOLLUSKS ...2.0289
CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER ...2.0290
MOLLUSCICIDES - A CORRELATION OF STRUCTURE VS. ACTIVITY ...2.0291
OYSTER DRIL (OCINEBRA JAPONICA) CONTROL ...2.0293
THE CONTROL OF SLUGS ...2.0294
DISEASE-RESISTANT OYSTERS ...3.0114
INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...4.0059

Lamellibranchiata -other

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...1.0143
PESTICIDE RESIDUES IN KANSAS STREAMS ...1.0150
PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0163
PESTICIDES MOVEMENT FROM CROPLAND INTO LAKE ERIE ...1.0193
THE UPTAKE OF DIELDRIN IN THE THREE RIDGED NAIAD, AMBLEMA PLICATA ...1.0301
MARINE PILING ANALYSIS ...2.0296
MULTIPLICATION OF ENTERIC VIRUSES IN SHELLFISH ...3.0069

Mollusca -other

PESTICIDE MONITORING PROGRAM ...1.0156
BEHAVIOR OF ESTUARINE ANIMALS ...1.0240
ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...1.0326
UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029
IDENTIFICATION OF PARASITES AND DISEASES EFFECTING MARICULTURE SPECIES ...3.0037
MARINE FISH-CULTURE PATHOLOGY ...3.0070

Ostreidae

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...1.0236
PESTICIDE MONITORING PROGRAM ...1.0238
LABORATORY BIOASSAYS ...1.0241
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE I ...2.0073
NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...2.0271
EXPERIMENTS TO RE-ESTABLISH HISTORICAL OYSTER SEED GROUNDS AND TO CONTROL THE SOUTHERN OYSTER DRILL ...2.0274
OYSTER DISEASE MORTALITY ALONG THE CALIFORNIA COAST ...3.0022
MOLLUSCAN MORTALITY STUDIES ...3.0032
SHELLFISH MORTALITY - CHESAPEAKE BAY ...3.0033
PACIFIC OYSTER MORTALITY STUDIES ...3.0034
MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...3.0060
SALT WATER POND RESEARCH ...3.0073
TESTING OF STOCKS OF OYSTERS FOR DISEASE RESISTANCE ...3.0077
ACQUIRED VS. GENETIC RESISTANCE IN OYSTERS ...3.0078
TESTS OF SELECTED SEED OYSTER STOCKS ON COMMERCIAL BEDS ...3.0079
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082
PATHOLOGY - EPIZOOTIOLOGY ...3.0113
DISEASE-RESISTANT OYSTERS ...3.0114
AQUICULTURE, OYSTER HATCHERIES - RESEARCH ...3.0118

Monitoring

ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN ...1.0132
GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152
PESTICIDE MONITORING PROGRAM ...1.0156
PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0163

PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166
AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...1.0186
PESTICIDES RESEARCH ...1.0232
EFFECTS OF TOXICANTS UPON FISH MOVEMENT PATTERNS ...1.0308
EFFECT OF COPPER SULFATE ON AQUATIC WEEDS ...2.0108
SHELLFISH MORTALITY - CHESAPEAKE BAY ...3.0033
PHYTOPLANKTON NUTRITION AND PHOTOSYNTHESIS IN EUTROPHIC LAKES ...4.0016
TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ...4.0030
DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...4.0051
NORTHERN PIKE LIFE HISTORY STUDY ...4.0084
WALLEYE LIFE HISTORY STUDY ...4.0085

Monitoring -pesticides

PESTICIDE RESIDUES ON ARIZONA CROPS ...1.0007
EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010
PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS ...1.0055
TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...1.0056
PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES ...1.0062
MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...1.0071
EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS ...1.0080
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0097
MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...1.0098
COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...1.0125
CHEMICAL ANALYSES ...1.0129
EFFLUENT INFLUENCES OF THE MISSISSIPPI RIVER ON THE CHEMISTRY AND BIOLOGY OF ADJACENT OCEAN SYSTEMS ...1.0130
EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133
PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...1.0143
GREAT LAKES PESTICIDE MONITORING PROGRAM, INDIANA ...1.0147
GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152
PESTICIDE MONITORING PROGRAM ...1.0156
MASSACHUSETTS PESTICIDE MONITORING STUDY ...1.0157
ADSORPTION OF PESTICIDES FROM SEA WATER ...1.0159
MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...1.0160
WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...1.0162
PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0163
PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0164
PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166
PRESTICIDE INPUTS AND LEVELS IN MINNESOTA WATERS OF THE LAKE SUPERIOR BASIN ...1.0167
PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...1.0170
RAPID DETECTION OF TOXIC MATERIALS IN WATER ...1.0180
AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...1.0186
DESIGNING A GLOBAL ENVIRONMENTAL MONITORING SYSTEM ...1.0206
DDT IN SNOW FALLEN AT HIGH ALTITUDE SINCE 1950 ...1.0214
DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215
PESTICIDE MONITORING ...1.0217
PESTICIDES RESEARCH ...1.0232
PESTICIDE MONITORING PROGRAM ...1.0238
PESTICIDE CONTAMINATION OF ENVIRONMENT ...1.0250
THE UPTAKE OF DIELDRIN IN THE THREE RIDGED NAIAD, AMBLEMA PLICATA ...1.0301
EFFECT OF PESTICIDE RESIDUES ON GAME FISH POPULATIONS ...1.0310
INVESTIGATION OF MEANS FOR CONTROLLED SELF-DESTRUCTION OF PESTICIDES ...1.0323
PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...1.0328
BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342
ENVIRONMENTAL TOXICOLOGY OF PESTICIDES ...1.0361
THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...1.0365

Montana

INSECT SURVEY OF MONTANA ...2.0058

Morbidity

ASSESSMENT OF THE IMPORTANCE OF FILARIASIS IN THAILAND ...4.0072

Motivation and Instinct

RELATIONSHIPS BETWEEN SUB-LETHAL PESTICIDES AND REPRODUCTION AND BEHAVIOR OF FISHES ...1.0245

Multiple Purpose Projects

WATER MANAGEMENT IN MOSQUITO IMPOUNDMENTS ...2.0064

Myriapoda

Chilopoda

ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

Natural Purification

GROUND AND SURFACE WATERS - POLLUTION ...1.0182

Nebraska

THE RELATIONSHIP BETWEEN THE USE OF AGRICULTURAL CHLORINATED HYDROCARBONS AND THEIR RESIDUES IN CHANNEL CATFISH ...1.0298

Nematoda

Animal Nematodes -nonspecific

TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...2.0007
FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...2.0053
INSECT SURVEY OF MONTANA ...2.0058

Filariodea

ASSESSMENT OF THE IMPORTANCE OF FILARIASIS IN THAILAND ...4.0072

Dirofilaria

MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...2.0062
BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...4.0058

Nematoda

Onchocerca

INSECTS AS VECTORS OF DISEASES OF MILITARY IMPORTANCE IN ETHIOPIA THEIR ECOLOGY AND CONTROL ...4.0067

Plant Nematodes -nonspecific

BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...2.0121

Plant Nematodes -other

MOLLUSCAN MORTALITY STUDIES ...3.0032
ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044

Strongyloidea

Strongylidae

SURVEY OF ANIMAL DISEASES IN CONNECTICUT ...3.0024

Strongyloidea -other

ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044

Neon

LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010

Neoplasm See Also Canker

SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA - CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...1.0268
EPIDERMAL PAPILLOMAS ...3.0021
SURVEY OF ANIMAL DISEASES IN CONNECTICUT ...3.0024
CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045
MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...3.0056
MARINE FISH-CULTURE PATHOLOGY ...3.0070
HISTOPATHOLOGY OF LIVERS OF RAINBOW TROUT FED RANCID PELLETS CONTAINING AFLATOXIN ...3.0081
NEOPLASMS OF SALMONID FISHES ...3.0094

Neutralization

TIME-CONCENTRATION TESTS INVOLVING NEUTRALIZATION OF ROTENONE WITH POTASSIUM PERMANGANATE ...2.0224
NEUTRALIZATION OF ROTENONE WITH ACTIVATED CHARCOAL ...2.0225

New Crops

ALLEVIATION OF LAKE POLLUTION BY UTILIZATION OF AQUATIC PLANTS FOR NUTRITIONAL, MEDICINAL OR INDUSTRIAL PURPOSES ...2.0152
ROTENOIDS FROM TEPHROSIA VOGELII ...2.0198

New Guinea

MOSQUITOES OF THE NEW GUINEA AREA ...4.0050

New Jersey

DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...1.0184

New Mexico

SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...1.0066
FATE OF POLLUTANTS IN GROUND WATER ...1.0079
GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081

New York

LEGAL REPRESENTATION OF CITIZEN'S INTERESTS IN ENVIRONMENTAL PROTECTION ...2.0069

Nitric Acid

ROTENOIDS FROM TEPHROSIA VOGELII ...2.0198

Nitrogen

PROPERTIES OF TILE DRAINAGE WATER ...1.0045
SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...1.0066
NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073
AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161
LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION ...1.0178
GROUND AND SURFACE WATERS - POLLUTION ...1.0182
AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...1.0186
QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204
PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260
PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...1.0289
DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...2.0094
FACTORS CONTROLLING THE GROWTH OF THE AQUATIC WEED SALVINIA ...2.0166
CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...2.0185
CORRELATE NITROGEN GAS CONTENT OF WATER SUPPLIES WITH DISEASE ...3.0088
INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...4.0001
RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY ...4.0002
THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER ...4.0004
TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005
RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...4.0019
THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0020

Ammonia

DISPOSITION OF PESTICIDES IN THE SOIL ...1.0031
CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105
PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260
RELATION OF APPLICATION METHODS, CONCENTRATION, AND VOLUME OF INSECTICIDE TO CATTLE INSECT CONTROL ...2.0039
FISH TOXICANT STUDIES ...2.0232
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082

Ammonium

EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...4.0023

Nitrates

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...1.0032

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053
FATE OF POLLUTANTS IN GROUND WATER ...1.0079
EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS ...1.0080
ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120
QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191
BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342
THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...2.0150
NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082
TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005
LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010
EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...4.0023
ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...4.0069
POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078

Nitrites

FACTORS AFFECTING ROLE OF MICROORGANISMS IN BIOLOGICAL CONTROL OF INSECT PESTS ...2.0037
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082

Nitrogen Gas

EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...3.0083
CORRELATE NITROGEN GAS CONTENT OF WATER SUPPLIES WITH DISEASE ...3.0088

Nitrogen Cycle

THE DISPOSITION OF PESTICIDES IN THE SOIL ...1.0030
BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083

Noise

BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN ...4.0047

Nomenclature, Classification

BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS ...2.0054

North Carolina

PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...1.0358
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE I ...2.0073

North Dakota

THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...1.0359

Nucleic Acids

INSECT CHEMOSTERILANTS ...2.0049
THE NUTRITION AND BEHAVIOR OF MOSQUITOES ...4.0033
BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS ...4.0061

Ocean Basins

RESEARCH VESSEL OPERATIONS ...3.0048

Ocean Instrumentation

GREEN BAY RESEARCH PROGRAM ...1.0112
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0140
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0158

Ohio

THE CHANGING DISTRIBUTION OF THE GENUS POTAMOGETON (PONDWEEDS) IN OHIO ...4.0026

Ohio River

THE UPTAKE OF DIELDRIN IN THE THREE RIDGED NAIAD, AMBLEMA PLICATA ...1.0301

Olefins

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086
CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER ...2.0290

Optica

Reflection

THE EFFECTS OF HERBICIDES, PESTICIDES, AND FERTILIZERS ON THE OPTICAL PROPERTIES OF WATER ...1.0177

Refraction

THE EFFECTS OF HERBICIDES, PESTICIDES, AND FERTILIZERS ON THE OPTICAL PROPERTIES OF WATER ...1.0177

Transmission

THE EFFECTS OF HERBICIDES, PESTICIDES, AND FERTILIZERS ON THE OPTICAL PROPERTIES OF WATER ...1.0177

Optical Properties

THE EFFECTS OF HERBICIDES, PESTICIDES, AND FERTILIZERS ON THE OPTICAL PROPERTIES OF WATER ...1.0177
GROUND AND SURFACE WATERS - POLLUTION ...1.0182
RESEARCH VESSEL OPERATIONS ...3.0048
BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...4.0012
POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078

Oregon

RESEARCH VESSEL OPERATIONS ...3.0048
MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...3.0060

Organic Acids

FARM FISH POND MANAGEMENT ...1.0340

Organic Evolution

POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038
BIOLOGICAL STUDIES OF MALACOPHAGOUS DIPTERA ...2.0282
STUDY THE BIOLOGY OF A GROUP OF SNAIL-KILLING FLIES ...2.0287
ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...4.0007

Organic Matter

WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...1.0005
EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010
SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL ...1.0012
VOLATILIZATION LOSSES OF PESTICIDES FROM SOILS ...1.0016
REACTIONS OF PESTICIDES WITH SOILS ...1.0020
REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...1.0021
CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...1.0024
NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029
HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...1.0035
POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...1.0036
EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041
PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...1.0075
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0084
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
BIOLOGY AND CONTROL OF PASTURE MOSQUITOES ...2.0008

Maintenance

BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083

Physical Property Effects

SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...1.0181

Organic Water Properties

SOILS, PESTICIDES, AND THE QUALITY OF WATER ...1.0103
ORGANIC SUBSTANCES IN WATER ...1.0119
QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187
CHLORINATED ORGANIC CONTAMINANTS IN THE MILWAUKEE RIVER ...1.0226

Organophosphorus Compounds

RAPID DETECTION OF TOXIC MATERIALS IN WATER ...1.0180

Oxalic Acid

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082
TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005

Oxidation

PHOTOCHEMICAL METHODS FOR PURIFYING WATER ...1.0115

Oxygen

INTERACTION OF HERBICIDES AND SOIL MICROORGANISMS ...1.0069
GROUND AND SURFACE WATERS - POLLUTION ...1.0182
RESEARCH STUDY ON THE EFFECTS OF POLLUTION ON SUB-TROPICAL FISH AND CRUSTACEANS ...1.0237
RESPIRATION RATES OF FISH-FOOD INVERTEBRATES EXPOSED TO PESTICIDES ...1.0355
FACTORS AFFECTING ROLE OF MICROORGANISMS IN BIOLOGICAL CONTROL OF INSECT PESTS ...2.0037
SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...2.0055
EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168
NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180
CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...2.0185
PISCICIDE TOXICOLOGY OF THE CYPRINIDS IN EAST AND WEST PAULINA LAKES ...2.0228
ENVIRONMENTAL STUDY ...3.0030
MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...3.0060
EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...3.0069
THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER ...4.0004
ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...4.0007
LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010
POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078
REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES ...4.0083

Oxides

PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...1.0033
INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106

Peroxides

EARLY SQUAMATION OF BLUEGILL (LEPOMIS MACROCHIRUS) AND FATHEAD MINNOWS (PIMEPHALES PROMELAS) EXPOSED TO AROCLORS ...1.0286

Pacific Ocean

PESTICIDE MONITORING PROGRAM ...1.0238
PACIFIC OYSTER MORTALITY STUDIES ...3.0034
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082

Packing & Container Types

DEVELOPMENT OF FIELD METHODS IN SAMPLING WATER FOR PESTICIDE ANALYSIS ...1.0173
PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105

Pakistan

NATURAL ENEMIES OF EURASIAN WATERMILFOIL IN PAKISTAN ...2.0173

Panama

BIOLOGICAL STUDIES OF CULICOIDES AND THEIR CONTROL IN THE CANAL ZONE ...4.0043

Parasitology - Animal

IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS ...1.0335

PACIFIC OYSTER MORTALITY STUDIES ...3.0034

IDENTIFICATION OF PARASITES AND DISEASES EFFECTING MARICULTURE SPECIES ...3.0037

AQUICULTURE, SALMON CULTURE - RESEARCH ...3.0053

WALLEYE AND NORTHERN PIKE STUDY ...3.0072

Ectoparasites

NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077

THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078

STUDY OF THE SEA LAMPREY IN LOVE LAKE ...2.0200

SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...2.0206

LAKE HURON CHEMICAL CONTROL ...2.0209

DISTRIBUTION OF THE GENUS ERGASILUS (PARASITIC COPEPOD) IN THE SOUTHEASTERN UNITED STATES ...3.0011

COOPERATIVE FISH DISEASE PROJECT ...3.0012

IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...3.0018

ENVIRONMENTAL STUDY ...3.0030

PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...3.0047

ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...3.0052

PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...3.0108

BIOCHEMICAL CHANGES IN FISH DISEASES - THE STRESS OF FORMALIN TREATMENTS IN SALMONID FISHES ...3.0124

TRANSMISSION OF ANAPLASMOSIS ...4.0032

ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044

NORTHERN PIKE LIFE HISTORY STUDY ...4.0084

Endoparasites

IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...3.0018

ENVIRONMENTAL STUDY ...3.0030

ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...3.0052

NORTHERN PIKE LIFE HISTORY STUDY ...4.0084

WALLEYE LIFE HISTORY STUDY ...4.0085

Helminths

DISTRIBUTION AND ECOLOGY OF PENNSYLVANIA SALAMANDERS ...2.0080

CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266

SCHISTOSOME CONTROL BY TREMATODE ANTAGONISM ...2.0270

THE BIOLOGY AND CONTROL OF THE SNAIL INTERMEDIATE HOST OF SCHISTOSOMES ...2.0276

BIOLOGY AND BIOLOGICAL CONTROL OF SCHISTOSOMIASIS ...2.0277

SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...2.0279

INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...2.0280

EPIZOOTIOLOGY OF PARASITIC DISEASES IN FISH POPULATIONS UNDER INTENSIVE MANAGEMENT ...3.0001

IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...3.0018

SURVEY OF ANIMAL DISEASES IN CONNECTICUT ...3.0024

REFINEMENT OF MANAGEMENT TECHNIQUES FOR STREAM TROUT LAKES ...3.0035

EXPERIMENTAL CONTROL OF NEASCUS IN SMALL TROUT LAKES ...3.0036

PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...3.0047

EPIDEMOLOGY OF 'SALMON POISONING' DISEASE ...3.0054

PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...3.0108

ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044

BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...4.0058

Protozoa

MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...2.0062

EPIZOOTIOLOGY OF PARASITIC DISEASES IN FISH POPULATIONS UNDER INTENSIVE MANAGEMENT ...3.0001

INVESTIGATIONS OF AMEBIASIS IN FISH ...3.0014

STUDY OF THE INCIDENCE AND LIFE CYCLES OF MYXOSPORIDIAL INFECTIONS IN WARM WATER FISHES (REVISED) ...3.0020

SURVEY OF ANIMAL DISEASES IN CONNECTICUT ...3.0024

SHELLFISH MORTALITY - CHESAPEAKE BAY ...3.0033

TRANSMISSION OF AN OVARY PARASITE OF THE GOLDEN SHINER ...3.0038

PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...3.0047

INFECTIOUS DISEASES OF SALMONID FISHES ...3.0049

BIOLOGY OF THE PROTOZOAN PARASITE CERATOMYXA SHASTA ...3.0050

USE OF CELL CULTURE METHODS TO ATTEMPT TO FOLLOW DEVELOPING STAGES OF SPORES ...3.0062

SUSCEPTIBILITY OF VARIOUS AGES OF FISH TO INFECTION ...3.0063

USE OF TISSUE SECTIONING TECHNIQUES TO ATTEMPT TO FOLLOW THE LIFE HISTORY OF WHIRLING DISEASE PARASITES FROM THE FIRST DAY OF INFECTION ...3.0065

TREATMENT OF WHIRLING DISEASE SPORES TO PRODUCE INFECTIVE STATES OF THE ORGANISM ...3.0066

DETERMINE IF SPORES OR INFECTIVE STAGES ARE SHED FROM LIVING FISH ...3.0068

PARASITOLOGY - PARASITES AND PARASITIC DISEASES OF FISHES - IMMUNIZATION STUDY FOR ICHTHYOPHTHIRIUS ...3.0100

PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...3.0108

CONTROL OF MYXOSPORIDIAN PARASITES ...3.0109

PATHOLOGY - EPIZOOTIOLOGY ...3.0113

PARASITES AND PARASITIC DISEASES OF FISHES - STUDY OF NEW METHODS FOR CONTROL OF ICHTHYOPHT ...3.0128

CONTROL OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA FILTRATION AND ULTRAVIOLET IRRADIATION ...3.0129

TRANSMISSION OF MICROSPORIDA ...3.0131

TRANSMISSION OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA ...3.0132

TRANSMISSION OF ANAPLASMOSIS ...4.0032

CULTIVATION OF INSECT PHASE OF AVIAN PLASMODIA ...4.0036

MOSQUITOES AS VECTORS OF LIVESTOCK DISEASES ...4.0065

Fieldcontrol of Parasites

CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266

Parasitology - Animal

- SCHISTOSOME CONTROL BY TREMATODE ANTAGONISM ...2.0270
- SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...2.0279
- REPRODUCTION & FUNGAL PARASITES AFFECTING REPRODUCTION IN LOBSTER, HUMARUS AMERICANNA, & BLUE CRAB CALLINECTES SAPIDUS, IN N.C. WATERS ...3.0115
- BIOCHEMICAL CHANGES IN FISH DISEASES - THE STRESS OF FORMALIN TREATMENTS IN SALMONID FISHES ...3.0124
- PARASITES AND PARASITIC DISEASES OF FISHES - STUDY OF NEW METHODS FOR CONTROL OF ICHTHYOPHT ...3.0128

Host - Parasite Interaction

- DISTRIBUTION OF THE GENUS ERGASILUS (PARASITIC COPEPOD) IN THE SOUTHEASTERN UNITED STATES ...3.0011
- COOPERATIVE FISH DISEASE PROJECT ...3.0012
- DISEASES OF FISH ...3.0025
- UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029
- MARINE FISHERIES - SYMBIOSIS AND PARASITISM - RESEARCH ...3.0055
- REPRODUCTION & FUNGAL PARASITES AFFECTING REPRODUCTION IN LOBSTER, HUMARUS AMERICANNA, & BLUE CRAB CALLINECTES SAPIDUS, IN N.C. WATERS ...3.0115
- ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044
- ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046
- FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES ...4.0080

Host Resistance

- CULTIVATION OF INSECT PHASE OF AVIAN PLASMODIA ...4.0036

Host Specificity of Parasites

- THE BIOLOGY AND CONTROL OF THE SNAIL INTERMEDIATE HOST OF SCHISTOSOMES ...2.0276
- SHELLFISH MORTALITY - CHESAPEAKE BAY ...3.0033
- PATHOLOGY - EPIZOOTIOLOGY ...3.0113

Reservoirs for Parasites

- BIOLOGY OF THE PROTOZOAN PARASITE CERATOMYXA SHASTA ...3.0050
- TRANSMISSION OF CERATOMYXA SHASTA ...3.0058

Aquatic

- BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...2.0269
- SCHISTOSOME CONTROL BY TREMATODE ANTAGONISM ...2.0270
- BIOLOGY AND BIOLOGICAL CONTROL OF SCHISTOSOMIASIS ...2.0277
- SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...2.0279
- METHOD OF KILLING ONCOMELANIA & AQUATIC SNAIL VECTORS OF SCHISTOSOMIASIS ...2.0285
- PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...3.0047

Terrestrial

- MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...2.0062
- BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...2.0269
- THE BIOLOGY AND CONTROL OF THE SNAIL INTERMEDIATE HOST OF SCHISTOSOMES ...2.0276
- BIOLOGY AND BIOLOGICAL CONTROL OF SCHISTOSOMIASIS ...2.0277
- INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...2.0280
- DEVELOPMENT OF A TOXIC BAIT ...2.0286
- TRANSMISSION OF ANAPLASMOSIS ...4.0032
- MOSQUITOES AS VECTORS OF LIVESTOCK DISEASES ...4.0065

Serology and Immunology

- EPIZOOTIOLOGY OF PARASITIC DISEASES IN FISH POPULATIONS UNDER INTENSIVE MANAGEMENT ...3.0001

Virulence

- INVESTIGATIONS OF AMEBIASIS IN FISH ...3.0014
- COOPERATIVE FISH PARASITE AND DISEASE STUDY ...3.0015

Pentynol

- EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...2.0234

Percolation

- PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...1.0094

Periphyton

- INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106
- LAKE SUPERIOR PERIPHYTON IN RELATION TO WATER QUALITY ...4.0017
- A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...4.0018

Persistance of Residues

- CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...1.0004
- WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...1.0005
- INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015
- ANALYTICAL METHODS FOR PESTICIDES IN SOIL AND WATER ...1.0018
- BEHAVIOR OF POLLUTANTS IN WATER ...1.0022
- PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...1.0032
- REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0037
- PROPERTIES OF TILE DRAINAGE WATER ...1.0045
- REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0046
- ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS ...1.0049
- PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...1.0052
- CONTROL OF PESTICIDES IN SOIL AND WATER ...1.0054
- TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...1.0056
- ANALYSIS OF PESTICIDE RESIDUES ...1.0058
- PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES ...1.0062
- PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS ...1.0063
- FATE OF PESTICIDES ...1.0064
- PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...1.0075
- FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL ...1.0077
- THE CYCLING OF CL-36 LABELED DDT IN NATURAL ECOSYSTEMS ...1.0078
- BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081
- BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083
- ANALYTICAL METHODS FOR PESTICIDES AND PESTICIDE DEGRADATION PRODUCTS ...1.0088

FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...1.0089
PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...1.0090
PERSISTENCE AND MODES OF HERBICIDE DISSIPATION UNDER RANGELAND CONDITIONS ...1.0096
MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099
ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106
HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...1.0107
IDENTIFICATION AND DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND RUNOFF AND DRAINAGE WATERS. ...1.0110
UPTAKE AND RELEASE OF DALAPON IN EARTHEN PONDS ...1.0114
DEVELOPMENT OF TREATMENT PROCESS FOR CHLORINATED HYDROCARBON PESTICIDE MANUFACTURING AND PROCESSING WASTES ...1.0118
COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...1.0125
PESTICIDE KINETICS ...1.0127
EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133
DEVELOP EFFECTIVE TREATMENT METHODS FOR HARD PESTIDICIDES ...1.0136
RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS ...1.0138
THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0144
RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146
LIMNOLOGICAL FACTORS AFFECTING PESTICIDE RESIDUES IN SURFACE WATERS ...1.0149
GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152
MASSACHUSETTS PESTICIDE MONITORING STUDY ...1.0157
PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0164
PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166
PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...1.0170
SERVICES FOR THE QUANTITATIVE ANALYSIS OF PESTICIDES IN SEAWATER AND BIOLOGICAL SAMPLES ...1.0172
PREPARATION OF CHLORINE-36 LABELED ORGANOCHLORINE PESTICIDES AND RELATED COMPOUNDS (PCB'S) ...1.0174
PESTICIDES MOVEMENT FROM CROPLAND INTO LAKE ERIE ...1.0193
RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION ...1.0194
DEVELOP EFFECTIVE TREATMENT METHODS FOR HARD PESTICIDES ...1.0197
TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE ...1.0201
TRANSFER OF PESTICIDES THROUGH SOILS, WATER, SEDIMENTS AND AQUATIC LIFE ...1.0202
DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215
IMPROVING WATER QUALITY BY REMOVAL OF PESTICIDE POLLUTANTS WITH AQUATIC PLANTS ...1.0216
OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...1.0219
MICROBIOLOGY OF FARM PONDS ...1.0220
EVALUATION OF PESTICIDE SOURCES AND LEVELS TRIBUTARY TO LAKES MICHIGAN AND SUPERIOR ...1.0221
TERMINAL RESIDUES OF CHLORINATED HYDROCARBON PESTICIDES IN LAKE MICHIGAN AND ASSOCIATED TRIBUTARIES ...1.0222
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0228
PESTICIDE MONITORING PROGRAM ...1.0238
PESTICIDE CONTAMINATION OF ENVIRONMENT ...1.0250
QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...1.0259
MAGNITUDE AND NATURE OF POLYCHLORINATED BIPHENYLS IN COHO SALMON ...1.0262
CHRONIC EFFECTS OF DURSBAN ON WARM-WATER FISH ...1.0282
THE EFFECT OF DIELDRIN ON SURVIVAL AND DEVELOPMENT OF FISH EGGS ...1.0300
PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES ...1.0306
RESIDUES OF THANITE IN FISH MUSCLE ...1.0314
RESIDUES OF TFM IN FISH--LA CROSSE ...1.0315
PESTICIDES AND WILDLIFE ...1.0324
PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...1.0328
FATE OF AQUATIC HERBICIDES IN THE AQUATIC ENVIRONMENT ...1.0329
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0334
EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS ...1.0341
BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342
TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...1.0344
PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...1.0358
ENVIRONMENTAL TOXICOLOGY OF PESTICIDES ...1.0361
CHEMICAL BIOCIDES IN LAKES ...1.0364
THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...1.0365
PESTICIDE LEVELS IN BIRDS WINTERING ON LAKE MICHIGAN ...1.0367
EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082
WEED CONTROL IN RICE PRODUCTION ...2.0097
CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101
PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105
HERBICIDE RESIDUES ...2.0109
CONTROL OF AQUATIC WEEDS ...2.0113
BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0118
AQUATIC PLANT CONTROL ...2.0128
THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...2.0150
DEVELOP A SELECTIVE ALGACIDE TO CONTROL NUISANCE ALGAL GROWTH ...2.0151
RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...2.0161
BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162
INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...2.0167
U.V. SPECTROPHOTOMETRY FOR THE IDENTIFICATION AND ESTIMATION OF QUINALDINE RESIDUE ...2.0237
THE EFFICACY OF MONSANTO NO. 51294 AS A FISH TOXICANT (LABORATORY) ...2.0243
THE EFFICACY AND PERSISTENCE OF FORMULATIONS OF ANTIMYCIN ...2.0244
ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

Pest Control -general

BIOLOGY OF PEST MOSQUITOES, AND CONTROL THROUGH COMMUNITY ACTION ...2.0004
SURVEY OF INSECT PROBLEMS IN MONTANA ...2.0059
THE CONTROL OF MOSQUITOES OF MILITARY IMPORTANCE AND THE PREVENTION OF MOSQUITO-BORNE DISEASES ...2.0074
ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202
BIOLOGY OF THE LARVAL SEA LAMPREY ...2.0210

THE INTERACTION OF THE WALLEYE AND WHITE SUCKER IN THE FISH POPULATION OF SOFT WATER LAKE IN NORTHEASTERN MINNESOTA ...2.0215

PLANNING FOR CREATION OF SALMONID FISHERIES IN LAKE ONTARIO ...2.0221

PRE-LAMPREY CONTROL INVENTORY OF FISH STOCKS ...2.0222

POPULATION DYNAMICS - LAKE TROUT ...2.0235

NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...2.0271

SEA NETTLE STUDIES IN CHESAPEAKE BAY, LIFE HISTORY AND ECOLOGY ...2.0273

SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...2.0279

EXPERIMENTAL CONTROL OF NEASCUS IN SMALL TROUT LAKES ...3.0036

Pest Control Equipment

AQUATIC PLANT CONTROL - EQUIPMENT FOR MECHANICAL AND CHEMICAL DESTRUCTION ...2.0147

IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...2.0181

Pest Control Evaluation

CLASSIFICATION, BIONOMICS, ECOLOGY CONTROL OF FOREST INSECTS (OTHER THAN SCOLYTIDAE) IN CAL. ...1.0321

ECOLOGICAL STUDIES OF WILDLIFE MANAGEMENT PRACTICES ...1.0327

BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...2.0006

BIOLOGY AND CONTROL OF MOSQUITOES IN IRRIGATED AND WATER MANAGEMENT AREAS ...2.0011

MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...2.0019

IDENTIFICATION AND CHARACTERIZATION OF MOSQUITO PATHOGENS ...2.0020

CULTIVATION OF COELOMOMYCES, A FUNGAL PARASITE OF MOSQUITOES ...2.0031

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043

BIOLOGICAL AND BIOCHEMICAL FACTORS INFLUENCING THE DEVELOPMENT OF LARVAL MOSQUITO POPULATIONS ...2.0052

BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057

MOSQUITO CONTROL - TIDAL MARSHES ...2.0063

CONTROLLING MOSQUITOES ON HAYING MEADOWS ...2.0066

CONTROL OF AQUATIC WEEDS BY USE OF N2-CO2-HE LASER SYSTEMS ...2.0091

BIOLOGICAL CONTROL OF WEEDS ...2.0102

MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...2.0124

NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135

EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...2.0170

IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...2.0181

METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186

BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...2.0269

Pesticidal Interaction -other

BIODEGRADATION OF PESTICIDES IN A FRESHWATER ECOSYSTEM - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0352

NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077

Pesticide Evaluation

CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...1.0004

RESPROUTING OF CHAPARRAL ...1.0017

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

THYROIDAL I125 UPTAKE IN IMMATURE CHANNEL CATFISH FOLLOWING EXPOSURE TO SELECTED TOXICANTS ...1.0272

STATIC BIOASSAY OF TRACERS AND DYES AGAINST FISH AND INVERTEBRATES ...1.0316

DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...1.0333

AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...1.0343

EFFECT OF MOSQUITO CONTROL CHEMICALS ON AQUATIC FAUNA ...2.0003

BIOLOGY AND CONTROL OF PASTURE MOSQUITOES ...2.0008

AERIAL DISPERSAL METHODS FOR CONCENTRATED INSECTICIDES ...2.0009

STUDIES ON INSECTICIDE RESISTANCE IN MOSQUITOES ...2.0017

SUPPRESSION AND ECOLOGY OF MOSQUITOES ...2.0018

INVESTIGATIONS OF PHEROMONES AS CHEMOSTERILANTS FOR INSECTS WITH SPECIAL REFERENCE TO SYNTHETIC QUEN SUBSTANCE AND ITS ANALOGUES ...2.0021

INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025

SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...2.0028

CONTROL OF CULEX NIGRIPALPUS BY STERILITY METHODS ...2.0032

RELATION OF APPLICATION METHODS, CONCENTRATION, AND VOLUME OF INSECTICIDE TO CATTLE INSECT CONTROL ...2.0039

BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...2.0040

MALARIA ERADICATION RESEARCH ...2.0051

SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...2.0055

ABUNDANCE, DISTRIBUTION AND CONTROL OF MISCELLANEOUS INSECTS, AFFECTING LIVESTOCK ...2.0056

SURVEY OF INSECT PROBLEMS IN MONTANA ...2.0059

COORDINATION OF MOSQUITO CONTROL IN NEW JERSEY ...2.0061

MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...2.0062

MOSQUITO CONTROL - TIDAL MARSHES ...2.0063

CONTROLLING MOSQUITOES ON HAYING MEADOWS ...2.0066

NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077

THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...2.0079

EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082

SUSCEPTIBILITY OR RESISTANCE OF MEDICALLY IMPORTANT INSECTS TO INSECTICIDES ON SELECTED AIR FORCE BASES ...2.0084

MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085

EFFECT OF BITING FLIES ON WEIGHT GAINS IN CATTLE ...2.0090

CHEMICAL CONTROL OF WEEDS IN PONDS ...2.0093

WEED CONTROL IN RICE PRODUCTION ...2.0097

WEED CONTROL IN RICE PRODUCTION ...2.0098

AQUATIC WEED CONTROL RESEARCH ...2.0100

CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104
PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105
INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106
AROMATIC SOLVENT AQUATIC HERBICIDES AND EMULSIFYING AGENT TESTING ...2.0107
GROWTH SUPPRESSION AND REDUCTION IN REGROWTH POTENTIAL OF AQUATIC WEEDS ...2.0110
LABORATORY STUDY OF AQUATIC ENVIRONMENTAL FACTORS AND PLANT GROWTH STAGES ON AQUATIC WEED GROWTH AND HERBICIDAL RESPONSE ...2.0111
AQUATIC PEST CONTROL ...2.0112
EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...2.0116
ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0117
WEED CONTROL IN CITRICULTURE ...2.0123
TESTING OF NEW HERBICIDES ...2.0125
TESTING OF METHODS OF HERBICIDE APPLICATION ...2.0126
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0129
AQUATIC WEED SUPPRESSION AND CONTROL IN LARGE CANALS ...2.0132
DETERMINATION OF THE EFFECTS OF A FERTILIZER-INDUCED PLANKTON TURBIDITY, SUPPLEMENTED BY HERBICIDES, ON SUBMERGED AQUATIC PLANTS ...2.0137
USE OF CHEMICALS ON RICE ...2.0140
FOREST AND FARM GAME HABITAT; FISH POND ...2.0143
EXPANDED AQUATIC PLANT CONTROL PROJECT ...2.0146
CONTROL OF CANADA THISTLE AND WATER WEEDS ...2.0158
STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...2.0159
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...2.0160
BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162
FACTORS CONTROLLING THE GROWTH OF THE AQUATIC WEED SALVINIA ...2.0166
WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...2.0176
ALGACIDES FOR USE IN WATER RECLAMATION AND REUSE SYSTEMS ...2.0177
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...2.0178
WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...2.0179
METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186
EXPERIMENTAL USE OF PESTICIDES FOR FISHERIES MANAGEMENT PURPOSES ...2.0189
STUDIES OF SHARK REPELLENTS AND OTHER ANTISHARK MEASURES ...2.0191
SEA LAMPREY CONTROL - LAKE HURON CHEMICAL CONTROL ...2.0204
SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...2.0206
SEA LAMPREY CONTROL - ASSESSMENT METHODS ...2.0208
EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP, SOFT-WATER LAKES ...2.0213
PLANNING FOR CREATION OF SALMONID FISHERIES IN LAKE ONTARIO ...2.0221
PRE-LAMPREY CONTROL INVENTORY OF FISH STOCKS ...2.0222
THE TOXICITY AND DETOXIFICATION OF THE ROTENONE FORMULATIONS USED IN FISH MANAGEMENT ...2.0226
PISCICIDE TOXICOLOGY OF THE CYPRINIDS IN EAST AND WEST PAULINA LAKES ...2.0228
EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT) ...2.0229
EVALUATE FISH TOXICANT (ANTIMYCIN) (EAGLE LAKE SEGMENT) ...2.0230
FISH TOXICANT STUDIES ...2.0232
THE EFFICACY OF QUINALDINE SULFATE - MS-222 AS AN ANESTHETIC FOR FISH IN THE LABORATORY - WARM SPRINGS ...2.0239
SELECTIVE REMOVAL OF VARIOUS FISH SPECIES WITH ANTIMYCIN ...2.0240
THE EFFICACY OF THANITE (ISOBORNYL THIOCYANOACETATE) AS A FISH COLLECTION AID ...2.0242
THE EFFICACY OF MONSANTO NO. 51294 AS A FISH TOXICANT (LABORATORY) ...2.0243
THE EFFICACY AND PERSISTENCE OF FORMULATIONS OF ANTIMYCIN ...2.0244
ESTABLISH MINIMUM DOSES OF ANTIMYCIN AND ROTENONE NEEDED FOR TOTAL KILLS OF TARGET FISHES ...2.0247
STATIC BIOASSAY OF ATTRACTANTS AND REPELLANTS AGAINST FISH AND INVERTEBRATES ...2.0258
THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...2.0261
CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266
EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...2.0267
THE BIOLOGY AND CONTROL OF THE SNAIL INTERMEDIATE HOST OF SCHISTOSOMES ...2.0276
'A METHOD OF DESTROYING ONCOMELANIA-THE SNAIL VECTOR OF SCHISTOSOMIASIS' ...2.0284
METHOD OF KILLING ONCOMELANIA & AQUATIC SNAIL VECTORS OF SCHISTOSOMIASIS ...2.0285
DEVELOPMENT OF A TOXIC BAIT ...2.0286
BIOLOGY AND CONTROL OF TERRESTIAL MOLLUSKS ...2.0289
MOLLUSCICIDES - A CORRELATION OF STRUCTURE VS. ACTIVITY ...2.0291
EFFECT OF PRETREATMENT MOLDING OF SOUTHERN PINE ON THE PERMANENCE OF THE PRESERVATIVE IN SEAWATER EXPOSURE ...2.0295
MARINE PILING ANALYSIS ...2.0296
PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...3.0108
CONTROL OF MYXOSPORIDIAN PARASITES ...3.0109
AQUICULTURE, OYSTER HATCHERIES - RESEARCH ...3.0118
PARASITES AND PARASITIC DISEASES OF FISHES - STUDY OF NEW METHODS FOR CONTROL OF ICHTHYOPHT ...3.0128
CONTROL OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA FILTRATION AND ULTRAVIOLET IRRADIATION ...3.0129
FEEDING HABITS OF MOSQUITO LARVAE ...4.0034
DEVELOPMENT OF CULTURE METHODS FOR MOSQUITOES ...4.0035
BASIC STUDIES ON THE BEHAVIOR AND PHYSIOLOGY OF INSECTS THAT AFFECT MAN ...4.0047
LABORATORY ANALYSIS OF INSECTICIDE EFFECTIVENESS AGAINST MEDICALLY IMPORTANT INSECTS ...4.0068
RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070

Pesticide Industry

PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES ...1.0062
CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0093
DEVELOPMENT OF TREATMENT PROCESS FOR CHLORINATED HYDROCARBON PESTICIDE MANUFACTURING AND PROCESSING WASTES ...1.0118
CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0210
DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215

Pesticide Residue in Animals

Animal Tox. or Resid. -other

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039

ESTUARINE ECOSYSTEMS ...**1.0128**

CHEMICAL ANALYSES ...**1.0129**

RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...**1.0146**

PRESTICIDE INPUTS AND LEVELS IN MINNESOTA WATERS OF THE LAKE SUPERIOR BASIN ...**1.0167**

SERVICES FOR THE QUANTITATIVE ANALYSIS OF PESTICIDES IN SEAWATER AND BIOLOGICAL SAMPLES ...**1.0172**

PREPARATION OF CHLORINE-36 LABELED ORGANOCHLORINE PESTICIDES AND RELATED COMPOUNDS (PCB'S) ...**1.0174**

CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...**1.0205**

OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...**1.0219**

PESTICIDES RESEARCH ...**1.0232**

THE OCCURRENCE OF PESTICIDE RESIDUES IN THE LOWER BRISBANE RIVER AND IN THE TISSUES OF ESTUARINE ANIMALS ...**1.0233**

BEHAVIOR OF ESTUARINE ANIMALS ...**1.0240**

PHYSIOLOGY OF ESTUARINE ORGANISMS ...**1.0242**

EFFECTS OF PESTICIDES ON MARINE ANIMALS ...**1.0244**

CONTINUOUS-FLOW BIOASSAY OF PESTICIDES TO EVALUATE THE ACUTE AND CHRONIC EFFECTS OF PESTICIDES TO FRESHWATER INVERTEBRATES ...**1.0294**

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...**1.0304**

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...**1.0305**

PESTICIDE TOXICITY TO MARINE FISH AND INVERTEBRATES ...**1.0307**

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...**1.0328**

THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...**1.0330**

ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...**1.0339**

AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...**1.0343**

TOXICITY HAZARD OF POLYCHOLORINATED BIPHENYLS TO AQUATIC LIFE ...**1.0347**

STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970 ...**1.0354**

RESPIRATION RATES OF FISH-FOOD INVERTEBRATES EXPOSED TO PESTICIDES ...**1.0355**

EFFECT OF MOSQUITO CONTROL CHEMICALS ON AQUATIC FAUNA ...**2.0003**

AQUATIC WEED CONTROL RESEARCH ...**2.0100**

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...**2.0104**

ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0117**

STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...**2.0255**

STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES ...**2.0256**

CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...**2.0259**

Domestic Animals

LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...**1.0212**

RELATION OF APPLICATION METHODS, CONCENTRATION, AND VOLUME OF INSECTICIDE TO CATTLE INSECT CONTROL ...**2.0039**

NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...**2.0077**

Insects - Beneficial

STUDY OF CHRONIC TOXICITY OF LINDANE TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...**1.0337**

EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS ...**1.0341**

AERIAL DISPERSAL METHODS FOR CONCENTRATED INSECTICIDES ...**2.0009**

Laboratory Animals

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0037**

METABOLISM OF ENDRIN IN PONDS ...**1.0113**

UPTAKE AND RELEASE OF DALAPON IN EARTHEN PONDS ...**1.0114**

THE BIOASSAY OF WATER POLLUTANTS WITH CULTURED MAMMALIAN CELLS ...**1.0200**

EFFECT OF ENDRIN ON EGG-SPERM FORMATION AND EMBRYONIC DEVELOPMENT ...**1.0229**

PRELIMINARY STUDIES ON ENDRIN AND OTHER PESTICIDE UPTAKES BY FINGERLING CHANNEL CATFISH ...**1.0231**

THE OCCURRENCE OF PESTICIDE RESIDUES IN THE LOWER BRISBANE RIVER AND IN THE TISSUES OF ESTUARINE ANIMALS ...**1.0233**

EFFECTS OF PESTICIDES ON AQUATIC ANIMALS IN THE ESTUARINE AND MARINE ENVIRONMENTS ...**1.0234**

BEHAVIOR OF ESTUARINE ANIMALS ...**1.0240**

LABORATORY BIOASSAYS ...**1.0241**

PHYSIOLOGY OF ESTUARINE ORGANISMS ...**1.0242**

RELATIONSHIPS BETWEEN SUB-LETHAL PESTICIDES AND REPRODUCTION AND BEHAVIOR OF FISHES ...**1.0245**

PHYSICAL AND CHEMICAL FACTORS AFFECTING FISH ...**1.0246**

EFFECTS OF CHRONIC SUBLETHAL DOSAGES OF DDT ON THE SWIMMING PERFORMANCE OF ATLANTIC SALMON PARR ...**1.0252**

THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...**1.0253**

FIELD STUDIES OF PESTICIDE EFFECTS ON FISHES ...**1.0257**

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...**1.0260**

LABORATORY BIOASSAYS TO DETERMINE TOXIC EFFECS OF METHOXYCHLOR IN FISH ...**1.0264**

THE UPTAKE OF AND BIOLOGICAL RESPONSES TO AROCLORS IN CHANNEL CATFISH ...**1.0267**

SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA - CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...**1.0268**

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0269**

EFFECTS ON THE SPERMIATION RESPONSE OF GOLDFISH AFTER EXPOSURE TO SELECTED PESTICIDES ...**1.0270**

NERVE IMPULSE TRANSMISSION CHARACTERISTICS OF ISOLATED FISH-NERVE PREPARATIONS PERFUSED WITH PHYSIOLOGICAL LEVELS OF SELECTED PESTICIDES ...**1.0271**

THYROIDAL I125 UPTAKE IN IMMATURE CHANNEL CATFISH FOLLOWING EXPOSURE TO SELECTED TOXICANTS ...**1.0272**

SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0273**

COMPARISON OF METHODS USED TO MEASURE ESTERASE ACTIVITY. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...**1.0274**

SEASONAL CHANGES IN ESTERASE ACTIVITY IN FISH AND INVERTEBRATES. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...**1.0275**

CHARACTERIZATION OF ESTERASE(S) PRESENT IN FISH BLOOD ...**1.0276**

SCREENING OF PESTICIDES AGAINST FISH AT COLUMBIA MISSOURI ...**1.0277**

THE INFLUENCES OF ENVIRONMENTAL CONDITIONS ON THE TOXICITY OF PESTICIDES ...**1.0278**

THE SUSCEPTIBILITY OF VARIOUS LIFE STAGES OF FRESHWATER FISHES TO THREE TOXICANTS ...**1.0279**

RELATIVE SUSCEPTIBILITIES OF FISH FAMILIES TO HERBICIDES ...**1.0280**

INVESTIGATION OF STRESS-INDUCED MOBILIZATION OF INSECTICIDE RESIDUES - CHRONIC TOXICITY OF PESTICIDES TO FISH ...**1.0281**

CHRONIC EFFECTS OF DURSBAN ON WARM-WATER FISH ...**1.0282**

CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...1.0285

EARLY SQUAMATION OF BLUEGILL (LEPOMIS MACROCHIRUS) AND FATHEAD MINNOWS (PIMEPHALES PROMELAS) EXPOSED TO AROCLORS ...1.0286

CHRONIC TOXICITY OF PESTICIDES TO FISH ...1.0287

PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...1.0289

PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...1.0290

MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...1.0292

UPTAKE AND METABOLISM BY FISH OF 2,4-D DIMETHYL AMINE SALT ...1.0293

CONTINUOUS-FLOW BIOASSAY OF PESTICIDES TO EVALUATE THE ACUTE AND CHRONIC EFFECTS OF PESTICIDES TO FRESHWATER INVERTEBRATES ...1.0294

METHOXYCHLOR-CAUSED EFFECTS ON CUTTHROAT TROUT PHYSIOLOGY - CHRONIC TOXICITY OF INSECTICIDES TO COLD-WATER FISH ...1.0296

THE EFFECT OF DIELDRIN ON SURVIVAL AND DEVELOPMENT OF FISH EGGS ...1.0300

BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...1.0303

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0305

EFFECT OF PESTICIDE RESIDUES ON GAME FISH POPULATIONS ...1.0310

EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - ORGANOCHLORINE PESTICIDES AND DISEASE RESISTANCE MECHANISMS OF RAINBOW TROUT ...1.0312

RESIDUES OF THANITE IN FISH MUSCLE ...1.0314

RESIDUES OF TFM IN FISH--LA CROSSE ...1.0315

CHRONIC TOXICITY OF PESTICIDES TO COLD-WATER FISH ...1.0318

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319

THE CHEMISTRY AND TOXICOLOGY OF AGRICULTURAL CHEMICALS ...1.0322

ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...1.0339

IN VITRO POTENCY OF SEVERAL ANTICHOLINESTERASE AGENTS WITH SELECTED MEMBERS OF THE AQUATIC ENVIRONMENT ...1.0348

INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0351

BIODEGRADATION OF PESTICIDES IN A FRESHWATER ECOSYSTEM - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0352

POND ECOLOGY AND PRODUCTION AS AFFECTED BY SIMAZINE ...1.0353

STUDY OF CHRONIC TOXICITY OF PARATHION TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0357

TOXICOLOGY OF PESTICIDES IN THE ENVIRONMENT ...1.0360

PHARMACOLOGICAL AND ECOLOGICAL EFFECTS OF PESTICIDES ...1.0362

SELECTIVE TOXICITY BY OPTICALLY ACTIVE PHOSPHONOTHIONATE PESTICIDES ...2.0086

ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089

CHEMICAL CONTROL OF WEEDS IN PONDS ...2.0093

AQUATIC PLANT CONTROL ...2.0128

EFFECTS OF METHOXYCHLOR ON THE CONDITIONING OF STRIPED BASS TO AN OLFACTORY STIMULUS ...2.0233

THE DEVELOPMENT OF ANALYTICAL METHODS CAPABLE OF MEASURING TFM RESIDUES IN FISH, WATER, AND OTHER COMPLEX SUBSTRATES ...2.0238

IN VIVO AND IN VITRO STUDIES ON THE MODE OF ACTION OF TFM ...2.0250

METABOLISM AND EXCRETION OF TFM ...2.0251

THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...2.0252

THE EFFECTS OF THANITE ON THE INORGANIC BLOOD CHEMISTRIES OF FISHES ...2.0253

CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER ...2.0290

TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS ...3.0112

Wildlife

Birds

PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0163

DESIGNING A GLOBAL ENVIRONMENTAL MONITORING SYSTEM ...1.0206

LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...1.0212

FACTORS AFFECTING PESTICIDE TOXICITY ...1.0255

THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...1.0297

FISHERY RESOURCES PROGRAM ...1.0317

REPRODUCTIVE PERFORMANCE OF FISH-EATING BIRDS IN NORTHERN CALIFORNIA ...1.0320

INVESTIGATION OF MEANS FOR CONTROLLED SELF-DESTRUCTION OF PESTICIDES ...1.0323

PESTICIDES AND WILDLIFE ...1.0324

SELECTED PESTICIDES VS. WILDLIFE IN AQUATIC ENVIRONMENTS ...1.0325

THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...1.0365

PESTICIDE LEVELS IN BIRDS WINTERING ON LAKE MICHIGAN ...1.0367

INSECTICIDES AND EGG-SHELL DEPOSITION ...1.0368

Fish

DEVELOPMENT OF A TECHNIQUE FOR THE CONTROLLED SELF-DESTRUCTION OF FIELD-APPLIED DDT ...1.0014

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0037

REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0046

RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...1.0057

HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...1.0107

DEVELOPMENT OF ON-SITE BIOASSAY METHODS ...1.0108

METABOLISM OF ENDRIN IN PONDS ...1.0113

CHEMICAL ANALYSES ...1.0129

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...1.0143

GREAT LAKES PESTICIDE MONITORING PROGRAM, INDIANA ...1.0147

PESTICIDE RESIDUES IN KANSAS STREAMS ...1.0150

GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152

MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...1.0160

PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0163

PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166

DESIGNING A GLOBAL ENVIRONMENTAL MONITORING SYSTEM ...1.0206

PESTICIDE MONITORING ...1.0217

OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...1.0219

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0228

PRELIMINARY STUDIES ON ENDRIN AND OTHER PESTICIDE UPTAKES BY FINGERLING CHANNEL CATFISH ...1.0231

PESTICIDES RESEARCH ...1.0232

CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...1.0235

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...1.0236

RESEARCH STUDY ON THE EFFECTS OF POLLUTION ON SUB-TROPICAL FISH AND CRUSTACEANS ...1.0237

ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...1.0239
BEHAVIOR OF ESTUARINE ANIMALS ...1.0240
LABORATORY BIOASSAYS ...1.0241
RELATIONSHIPS BETWEEN SUB-LETHAL PESTICIDES AND REPRODUCTION AND BEHAVIOR OF FISHES ...1.0245
CONTAMINATION OF CHANNEL CATFISH WITH DIELDRIN FROM AGRICULTURAL RUNOFF ...1.0247
ENZYME AND TISSUE ALTERATIONS IN FISH - A MEASURE OF WATER QUALITY ...1.0248
EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...1.0249
PESTICIDE CONTAMINATION OF ENVIRONMENT ...1.0250
TOXICITY OF POLLUTANTS TO STRIPED BASS ...1.0251
THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...1.0253
PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES ...1.0254
FACTORS AFFECTING PESTICIDE TOXICITY ...1.0255
RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...1.0256
PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260
BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH ...1.0261
MAGNITUDE AND NATURE OF POLYCHLORINATED BIPHENYLS IN COHO SALMON ...1.0262
STREAM STUDIES TO DETERMINE TOXIC EFFECTS OF METHOXYCHLOR IN FISH POPULATIONS ...1.0263
LABORATORY BIOASSAYS TO DETERMINE TOXIC EFFECS OF METHOXYCHLOR IN FISH ...1.0264
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0265
MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...1.0266
CHRONIC EFFECTS OF DURSBAN ON WARM-WATER FISH ...1.0282
PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0291
UPTAKE AND METABOLISM BY FISH OF 2,4-D DIMETHYL AMINE SALT ...1.0293
THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...1.0297
THE RELATIONSHIP BETWEEN THE USE OF AGRICULTURAL CHLORINATED HYDROCARBONS AND THEIR RESIDUES IN CHANNEL CATFISH ...1.0298
ACCUMULATION OF PESTICIDES IN MENHADEN ...1.0299
TOXICITY OF SELECTED METALS TO CONDITIONED FISH ...1.0302
BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...1.0303
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0304
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0305
PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES ...1.0306
PESTICIDE TOXICITY TO MARINE FISH AND INVERTEBRATES ...1.0307
INHIBITORY EFFECT OF DDT IN ATPASE ASSAY MIXTURES ...1.0309
ELIMINATE OR REDUCE EFFECTS OF PESTICIDE RESIDUES ...1.0311
SUBLETHAL AMOUNTS OF ORGANIC INSECTICIDES AND FISH ...1.0313
FISHERY RESOURCES PROGRAM ...1.0317
CHRONIC TOXICITY OF PESTICIDES TO COLD-WATER FISH ...1.0318
PESTICIDES AND WILDLIFE ...1.0324
THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0330
ILLINOIS LAWS AFFECTING AGRICULTURE ...1.0332
IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS ...1.0335
STUDY OF CHRONIC TOXICITY OF LINDANE TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0337
ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...1.0339
BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342
IN VITRO POTENCY OF SEVERAL ANTICHOLINESTERASE AGENTS WITH SELECTED MEMBERS OF THE AQUATIC ENVIRONMENT ...1.0348
CHEMICAL BIOCIDES IN LAKES ...1.0364
INSECTICIDES AND EGG-SHELL DEPOSITION ...1.0368
INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025
CHEMICAL CONTROL OF WEEDS IN PONDS ...2.0093
PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105
AQUATIC PLANT CONTROL ...2.0128
ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202
LAKE HURON CHEMICAL CONTROL ...2.0209
STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0255
CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0259
THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...2.0261
CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS ...2.0265

Mammals

DESIGNING A GLOBAL ENVIRONMENTAL MONITORING SYSTEM ...1.0206
CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...1.0235
FACTORS AFFECTING PESTICIDE TOXICITY ...1.0255
EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082

Wildlife Toxicity -other

PESTICIDE LEVELS IN WATER AND WILDLIFE OF REELFOOT LAKE, TENNESSEE ...1.0208
PESTICIDE MONITORING PROGRAM ...1.0238
ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...1.0239
PESTICIDES AND WILDLIFE ...1.0324

Pesticide Residues -general

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0141

Pesticide Residues in Humans

Human Tox. or Residues -other

CENTER FOR STUDY OF THE HUMAN ENVIRONMENT ...1.0190
THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...1.0365

Residues in Foods

INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015
REDUCTION OF PESTICIDE RESIDUE HAZARDS ...1.0040
FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL ...1.0077
PESTICIDE CONTAMINATION OF ENVIRONMENT ...1.0250
QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...1.0259
PESTICIDE RESIDUES IN OR ON PAW AGRICULTURAL COMMODITIES ...1.0306
EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS ...1.0341
TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...1.0344
LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN ...4.0082

Residues in Potable Water

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...1.0032
REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...1.0047
PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...1.0052
EFFECTIVENESS OF IODINE FOR DISINFECTION OF PUBLIC WATER SUPPLIES & TO DETERMINE PHYSIOLOGICAL EFFECTS ON A HUMAN POPULATION ...1.0126
EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155
GROUND AND SURFACE WATERS - POLLUTION ...1.0182
PESTICIDE LEVELS IN WATER AND WILDLIFE OF REELFOOT LAKE, TENNESSEE ...1.0208
FATE OF AQUATIC HERBICIDES IN THE AQUATIC ENVIRONMENT ...1.0329
AQUATIC PLANT CONTROL ...2.0128

Pesticide Selectivity

ANALYTICAL METHODS FOR PESTICIDES AND PESTICIDE DEGRADATION PRODUCTS ...1.0088
DEVELOPMENT OF ON-SITE BIOASSAY METHODS ...1.0108
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
IN VITRO POTENCY OF SEVERAL ANTICHOLINESTERASE AGENTS WITH SELECTED MEMBERS OF THE AQUATIC ENVIRONMENT ...1.0348
INVESTIGATIONS OF THE ACTION OF CHEMOSTERILANTS ON HOUSEFLIES AND OTHER MEDICALLY IMPORTANT ARTHROPODS ...2.0026
BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115
DEVELOP A SELECTIVE ALGACIDE TO CONTROL NUISANCE ALGAL GROWTH ...2.0151
CONTROL OF CANADA THISTLE AND WATER WEEDS ...2.0158
WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...2.0176
CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187
SOUAWFISH STUDIES--ST. JOE RIVER, IDAHO ...2.0196
SEA LAMPREY CONTROL - LAKE MICHIGAN CHEMICAL CONTROL ...2.0203
LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...2.0205
SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...2.0207
LAKE HURON CHEMICAL CONTROL ...2.0209
BIOASSAY ...2.0211
FISH TOXICANT STUDIES ...2.0232
SELECTIVE REMOVAL OF VARIOUS FISH SPECIES WITH ANTIMYCIN ...2.0240
THE EFFICACY OF THANITE (ISOBORNYL THIOCYANOACETATE) AS A FISH COLLECTION AID ...2.0242
THE EFFICACY AND PERSISTENCE OF FORMULATIONS OF ANTIMYCIN ...2.0244
IN VIVO AND IN VITRO STUDIES ON THE MODE OF ACTION OF TFM ...2.0250
THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...2.0252
THE EFFECTS OF THANITE ON THE ACID-BASE BALANCE IN THE BLOOD OF FISHES ...2.0254

Pesticide Stability

LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...1.0212

Pesticides

Adjuvants

EFFECT OF BITING FLIES ON WEIGHT GAINS IN CATTLE ...2.0090

Aroclor -see Polychlorinated

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019
THE UPTAKE OF AND BIOLOGICAL RESPONSES TO AROCLORS IN CHANNEL CATFISH ...1.0267
EARLY SQUAMATION OF BLUEGILL (LEPOMIS MACROCHIRUS) AND FATHEAD MINNOWS (PIMEPHALES PROMELAS) EXPOSED TO AROCLORS ...1.0286
CHRONIC TOXICITY OF PESTICIDES TO FISH ...1.0287
CHRONIC TOXICITY OF PESTICIDES TO COLD-WATER FISH ...1.0318
THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM ...1.0350
INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0351

Carboset

METHOD OF KILLING ONCOMELANIA & AQUATIC SNAIL VECTORS OF SCHISTOSOMIASIS ...2.0285

DMSO

INHIBITORY EFFECT OF DDT IN ATPASE ASSAY MIXTURES ...1.0309

Tropical

BIOLOGICAL EVALUATION OF INSECT CONTROL AGENTS ...2.0050

Algacides

CHEMICAL CONTROL OF WEEDS IN PONDS ...2.0093
INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106
A STUDY OF INHIBITORY COMPOUNDS PRODUCED BY FRESH-WATER ALGAE ...2.0138
DEVELOP A SELECTIVE ALGACIDE TO CONTROL NUISANCE ALGAL GROWTH ...2.0151
ALGACIDES FOR USE IN WATER RECLAMATION AND REUSE SYSTEMS ...2.0177

Copper Sulfate

TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...1.0056
HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...1.0107
AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...1.0343
CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101
EFFECT OF COPPER SULFATE ON AQUATIC WEEDS ...2.0108
AQUATIC PEST CONTROL ...2.0112
EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...2.0116
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0118
BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162
AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO ...2.0227
THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0020

Antihelminth

Antihelminth Bilevon -m

PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...3.0108

Antimammal

Diphacin

CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...1.0235

Antiprotozoal

PARASITES AND PARASITIC DISEASES OF FISHES - STUDY OF NEW METHODS FOR CONTROL OF ICHTHYOPHT ...3.0128

Arsenicals -nonspecific

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0002

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0097

Avicide - Rodenticide

Strychnine

STUDIES OF SHARK REPELLENTS AND OTHER ANTISHARK MEASURES ...2.0191

Bactericides

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

Hexachlorophene

BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...1.0303

Bromine

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

Carbamates -nonspecific

CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...1.0004

INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0043

ANALYSIS OF PESTICIDE RESIDUES ...1.0058

PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES ...1.0062

FLUORESCENT PROBES IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS FOR WATER POLLUTION ...1.0137

RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146

A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0168

AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...1.0186

QUANTITATIVE METHODS FOR PESTICIDES IN NATURAL WATERS ...1.0198

ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...1.0239

PESTICIDE CONTAMINATION OF ENVIRONMENT ...1.0250

SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA - CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...1.0268

RESPIRATION RATES OF FISH-FOOD INVERTEBRATES EXPOSED TO PESTICIDES ...1.0355

EVALUATION OF NEW INSECTICIDES ...2.0015

STUDIES ON INSECTICIDE RESISTANCE IN MOSQUITOES ...2.0017

SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...2.0055

ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089

Chlorinated Hydrocarbons

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013

INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0043

PROPERTIES OF TILE DRAINAGE WATER ...1.0045

ANALYSIS OF PESTICIDE RESIDUES ...1.0058

FATE OF POLLUTANTS IN GROUND WATER ...1.0079

GREEN BAY RESEARCH PROGRAM ...1.0112

DEVELOPMENT OF TREATMENT PROCESS FOR CHLORINATED HYDROCARBON PESTICIDE MANUFACTURING AND PROCESSING WASTES ...1.0118

ORGANIC SUBSTANCES IN WATER ...1.0119

CHEMICAL ANALYSES ...1.0129

EFFLUENT INFLUENCES OF THE MISSISSIPPI RIVER ON THE CHEMISTRY AND BIOLOGY OF ADJACENT OCEAN SYSTEMS ...1.0130

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...1.0143

RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146

THE FACTOR CONTROLLING THE DYNAMICS OF NON-IONIC SYNTHETIC ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS ...1.0148

LIMNOLOGICAL FACTORS AFFECTING PESTICIDE RESIDUES IN SURFACE WATERS ...1.0149

GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

ADSORPTION OF PESTICIDES FROM SEA WATER ...1.0159

DEVELOPMENT OF FIELD METHODS IN SAMPLING WATER FOR PESTICIDE ANALYSIS ...1.0173

TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE ...1.0201

TRANSFER OF PESTICIDES THROUGH SOILS, WATER, SEDIMENTS AND AQUATIC LIFE ...1.0202

PESTICIDE LEVELS IN WATER AND WILDLIFE OF REELFOOT LAKE, TENNESSEE ...1.0208

DDT IN SNOW FALLEN AT HIGH ALTITUDE SINCE 1950 ...1.0214

PESTICIDE MONITORING ...1.0217

OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...1.0219

EVALUATION OF PESTICIDE SOURCES AND LEVELS TRIBUTARY TO LAKES MICHIGAN AND SUPERIOR ...1.0221

RESEARCH STUDY ON THE EFFECTS OF POLLUTION ON SUB-TROPICAL FISH AND CRUSTACEANS ...1.0237

ENZYME AND TISSUE ALTERATIONS IN FISH - A MEASURE OF WATER QUALITY ...1.0248

A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0265

NERVE IMPULSE TRANSMISSION CHARACTERISTICS OF ISOLATED FISH-NERVE PREPARATIONS PERFUSED WITH PHYSIOLOGICAL LEVELS OF SELECTED PESTICIDES ...1.0271

THYROIDAL I125 UPTAKE IN IMMATURE CHANNEL CATFISH FOLLOWING EXPOSURE TO SELECTED TOXICANTS ...1.0272

ACCUMULATION OF PESTICIDES IN MENHADEN ...1.0299

BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...1.0303

SUBLETHAL AMOUNTS OF ORGANIC INSECTICIDES AND FISH ...1.0313

PESTICIDES AND WILDLIFE ...1.0324

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...1.0328

MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS ...1.0338

INFLUENCE OF PROTOZOAN ACTIVITY ON HALOGENATED HYDROCARBON RESIDUES - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0349

RESPIRATION RATES OF FISH-FOOD INVERTEBRATES EXPOSED TO PESTICIDES ...1.0355

ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089

INFLUENCE OF PESTICIDES & OTHER HYDROCARBONS ON GROWTH OF EURYTOLERANT MICROALGAE ...2.0148

ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202

Cyanides -nonspecific

STUDIES OF SHARK REPELLENTS AND OTHER ANTISHARK MEASURES ...2.0191

GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081

Cyclodiene Cpds. -nonspecific

A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0168

Disinfectants & Antiseptics

EFFECTIVENESS OF IODINE FOR DISINFECTION OF PUBLIC WATER SUPPLIES & TO DETERMINE PHYSIOLOGICAL EFFECTS ON A HUMAN POPULATION ...1.0126

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155
USE OF CELL CULTURE METHODS TO ATTEMPT TO FOLLOW DEVELOPING STAGES OF SPORES ...3.0062
CONTROL OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA FILTRATION AND ULTRAVIOLET IRRADIATION ...3.0129
EFFECT OF DISINFECTING AGENTS ON M. CEREBRALIS ...3.0130

Acriflavine

TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS ...3.0112

CTAB

STUDY OF ELECTROHYDRAULIC WATER TREATMENT ...1.0121

Formalin

BIOCHEMICAL CHANGES IN FISH DISEASES - THE STRESS OF FORMALIN TREATMENTS IN SALMONID FISHES ...3.0124

Potassium Permanganate

DEVELOPMENT OF ACCURATE CHEMICAL INTRODUCTION TECHNIQUES ...2.0223
TIME-CONCENTRATION TESTS INVOLVING NEUTRALIZATION OF ROTENONE WITH POTASSIUM PERMANGANATE ...2.0224
AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO ...2.0227
TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS ...3.0112

Fumigant

WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...2.0179

Acrylonitrile

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086

Fungicides

Cuprous Oxide

INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106

Dichlone

REDUCTION OF PESTICIDE RESIDUE HAZARDS ...1.0040

Ferbam

LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...1.0212

Fungicides -nonspecific

CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...1.0235
SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA - CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...1.0268

Malachite Green

PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...3.0108
TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS ...3.0112

Tributyltinoxide

INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106
METHOD OF KILLING ONCOMELANIA & AQUATIC SNAIL VECTORS OF SCHISTOSOMIASIS ...2.0285

Herbicides

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0038
MOVEMENT OF HERBICIDES IN SOIL BY MASS FLOW ...1.0044
INACTIVATION AND LOSS PESTICIDES FROM SOIL ...1.0048
CONTROL OF PESTICIDES IN SOIL AND WATER ...1.0054
RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...1.0057
INTERACTION OF HERBICIDES AND SOIL MICROORGANISMS ...1.0069
SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072
NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073
FATES OF AGRICULTURAL CHEMICALS IN SOILS ...1.0092
PERSISTENCE AND MODES OF HERBICIDE DISSIPATION UNDER RANGELAND CONDITIONS ...1.0096
MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099
EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...1.0100
QUALITY OF IRRIGATION RETURN FLOW ...1.0102
ORGANIC SUBSTANCES IN WATER ...1.0119
POLLUTION LOADS IN RUNOFF FROM SMALL AGRICULTURAL WATERSHEDS ...1.0154
DEVELOPMENT OF ANALYTICAL METHODS FOR SELECTED HERBICIDES ...1.0175
THE EFFECTS OF HERBICIDES, PESTICIDES, AND FERTILIZERS ON THE OPTICAL PROPERTIES OF WATER ...1.0177
QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187
THE BIOASSAY OF WATER POLLUTANTS WITH CULTURED MAMMALIAN CELLS ...1.0200
MICROBIOLOGY OF FARM PONDS ...1.0220
SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA - CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...1.0268
RELATIVE SUSCEPTIBILITIES OF FISH FAMILIES TO HERBICIDES ...1.0280
ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...1.0326
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0334
THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM ...1.0350
AQUATIC WEED CONTROL RESEARCH ...2.0100
WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104
AROMATIC SOLVENT AQUATIC HERBICIDES AND EMULSIFYING AGENT TESTING ...2.0107
HERBICIDE RESIDUES ...2.0109
GROWTH SUPPRESSION AND REDUCTION IN REGROWTH POTENTIAL OF AQUATIC WEEDS ...2.0110
LABORATORY STUDY OF AQUATIC ENVIRONMENTAL FACTORS AND PLANT GROWTH STAGES ON AQUATIC WEED GROWTH AND HERBICIDAL RESPONSE ...2.0111
TESTING OF NEW HERBICIDES ...2.0125
TESTING OF METHODS OF HERBICIDE APPLICATION ...2.0126
AQUATIC PLANT CONTROL ...2.0128
AQUATIC WEED SUPPRESSION AND CONTROL IN LARGE CANALS ...2.0132
GROWTH REGULATORS AND MINERAL NUTRITION IN AQUATIC PLANT CONTROL ...2.0134
DETERMINATION OF THE EFFECTS OF A FERTILIZER-INDUCED PLANKTON TURBIDITY, SUPPLEMENTED BY HERBICIDES, ON SUBMERGED AQUATIC PLANTS ...2.0137
FOREST AND FARM GAME HABITAT; FISH POND ...2.0143
EXPANDED AQUATIC PLANT CONTROL PROJECT ...2.0146
AQUATIC PLANT CONTROL - EQUIPMENT FOR MECHANICAL AND CHEMICAL DESTRUCTION ...2.0147
THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...2.0150
EVALUATION OF POND CONDITIONS FOLLOWING FERTILIZATION ...2.0153
CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...2.0154
CONTROL OF CANADA THISTLE AND WATER WEEDS ...2.0158
STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...2.0159

WATERLEVEL MANAGEMENT ON IMPOUNDMENTS OF LOW QUALITY SOILS ...2.0163

FACTORS CONTROLLING THE GROWTH OF THE AQUATIC WEED SALVINIA ...2.0166

WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...2.0179

CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...2.0185

METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186

Acrolein

HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...1.0107

COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...1.0125

CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101

Alachlor

CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025

COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145

Ametryn

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034

HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...1.0035

EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...2.01[illegible]6

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0118

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0129

Amiben

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061

Amino Triazole

INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053

BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083

FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...1.0089

RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...2.0161

CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...2.0178

Amitrole T

CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187

Atrazine

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0002

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034

HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...1.0035

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061

PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS ...1.0063

PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...1.0090

PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...1.0094

FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095

MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191

DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...1.0196

Benefin

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0002

Bromacil

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010

CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187

CIPC

ANALYTICAL METHODS FOR PESTICIDES AND PESTICIDE DEGRADATION PRODUCTS ...1.0088

ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106

Copper Nitrate

CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101

Cotoran

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0009

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0091

CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...1.0189

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0228

CP 53619

WEED CONTROL IN RICE PRODUCTION ...2.0097

USE OF CHEMICALS ON RICE ...2.0140

D B E E, -2,4-

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0228

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319

CHEMICAL CONTROL OF WEEDS IN PONDS ...2.0093

PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105

D, 2,4-

INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015

RESPROUTING OF CHAPARRAL ...1.0017

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023

FATE OF PESTICIDES ...1.0064

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065

MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...1.0071

FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL ...1.0077

BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0084

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0085

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105

HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...1.0107

COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...1.0125

COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
PESTICIDE RESIDUES IN KANSAS STREAMS ...1.0150
TOXICITY OF POLLUTANTS TO STRIPED BASS ...1.0251
UPTAKE AND METABOLISM BY FISH OF 2,4-D DIMETHYL AMINE SALT ...1.0293
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319
AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...1.0343
PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105
CONTROL OF AQUATIC WEEDS ...2.0113
BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0118
CONTROL OF EURASIAN MILFOIL ...2.0156
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...2.0160
BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162
CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187

Dalapon
INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015
FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...1.0089
UPTAKE AND RELEASE OF DALAPON IN EARTHEN PONDS ...1.0114
CHEMICAL CONTROL OF DITCHBANK WEEDS IN PEAT AND SANDY SOIL AREAS OF SOUTH FLORIDA ...2.0114
WEED CONTROL IN CITRICULTURE ...2.0123
RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...2.0161
BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...2.0178
CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187

Dicamba
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061
MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...1.0071
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...2.0160
RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...2.0161

Dichlobenil
INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0228
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319
PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105
CONTROL OF AQUATIC WEEDS ...2.0113
BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115
WEED CONTROL IN CITRICULTURE ...2.0123
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0129
INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...2.0167

Diphenamid
FATE OF PESTICIDES ...1.0064

Diquat
INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0228
TOXICITY OF POLLUTANTS TO STRIPED BASS ...1.0251
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319
FATE OF AQUATIC HERBICIDES IN THE AQUATIC ENVIRONMENT ...1.0329
AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...1.0343
CHEMICAL CONTROL OF WEEDS IN PONDS ...2.0093
CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101
PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105
BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115
EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...2.0116
ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0117
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0118
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0129
INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...2.0167

Diuron
EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010
INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034
FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...1.0089
CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101
WEED CONTROL IN CITRICULTURE ...2.0123
CONTROL OF UNDESIRABLE AQUATIC VEGETATION ...2.0155

Endothall
INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015
TOXICITY OF POLLUTANTS TO STRIPED BASS ...1.0251
FATE OF AQUATIC HERBICIDES IN THE AQUATIC ENVIRONMENT ...1.0329
AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...1.0343
BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115
EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...2.0116
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0118
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0129

Eptam
CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025

ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...**1.0106**
WEED CONTROL IN CITRICULTURE ...**2.0123**

Fenac
BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0115**
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...**2.0160**
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...**2.0178**
CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...**2.0187**

Fenuron
WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...**1.0005**
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0076**
CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...**2.0187**

Herban
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0076**

Igran
CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...**2.0101**

Isocil
CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...**2.0187**

Linuron
FATE OF PESTICIDES ...**1.0064**

MSMA
LEACHING OF SELECTED HERBICIDES IN ALABAMA SOILS ...**1.0001**

Maloran
PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...**1.0087**

Molinate
WEED CONTROL IN RICE PRODUCTION ...**2.0097**
WEED CONTROL IN RICE PRODUCTION ...**2.0098**

Monuron
FATE OF PESTICIDES ...**1.0064**
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0076**

Paraquat
ANALYTICAL METHODS FOR PESTICIDES IN SOIL AND WATER ...**1.0018**
FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...**1.0089**
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...**1.0145**
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...**1.0228**
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...**1.0319**
CHEMICAL CONTROL OF WEEDS IN PONDS ...**2.0093**
ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0117**
WEED CONTROL IN CITRICULTURE ...**2.0123**
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0129**
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...**2.0178**

Patoran
FATE OF PESTICIDES ...**1.0064**
PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...**1.0087**

Phenoxy Herbicide -nonspecific
RESPROUTING OF CHAPARRAL ...**1.0017**
BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...**1.0083**
ORGANIC SUBSTANCES IN WATER ...**1.0119**
WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...**2.0176**

Picloram
LEACHING OF SELECTED HERBICIDES IN ALABAMA SOILS ...**1.0001**
CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...**1.0004**
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0006**
RESPROUTING OF CHAPARRAL ...**1.0017**
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0023**
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0034**
SOILS, PESTICIDES AND THE QUALITY OF WATER ...**1.0061**
SOILS, PESTICIDES AND THE QUALITY OF WATER ...**1.0065**
MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...**1.0071**
BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...**1.0083**
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0084**
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0085**
PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...**1.0094**
MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...**1.0099**
SOILS, PESTICIDES, AND THE QUALITY OF WATER ...**1.0103**
SOILS, PESTICIDES AND THE QUALITY OF WATER ...**1.0105**
ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...**1.0106**
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...**2.0160**
CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...**2.0187**

Planavin
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0002**
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0009**
ANALYTICAL METHODS FOR PESTICIDES IN SOIL AND WATER ...**1.0018**
RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...**1.0019**

Preforan
FATE OF HERBICIDES IN PLANTS AND SOILS ...**1.0095**

Prometone
BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...**1.0053**

Prometryne
INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...**1.0008**
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...**1.0081**
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...**1.0091**

Propachlor
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...**1.0145**

Propanil
WEED CONTROL IN RICE PRODUCTION ...**2.0097**
WEED CONTROL IN RICE PRODUCTION ...**2.0098**
USE OF CHEMICALS ON RICE ...**2.0140**

Propazine
MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...**1.0099**

Pyrazon
- PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023

Pyriclor
- PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...1.0075

RP 17623
- WEED CONTROL IN RICE PRODUCTION ...2.0097
- USE OF CHEMICALS ON RICE ...2.0140

Silvex
- INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015
- HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...1.0107
- PESTICIDE RESIDUES IN KANSAS STREAMS ...1.0150
- TOXICITY OF POLLUTANTS TO STRIPED BASS ...1.0251
- AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...1.0343
- PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105
- BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115
- WEED CONTROL IN CITRICULTURE ...2.0123
- THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0129

Simazine
- INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015
- PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034
- HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...1.0035
- PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS ...1.0053
- FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...1.0089
- EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319
- POND ECOLOGY AND PRODUCTION AS AFFECTED BY SIMAZINE ...1.0353
- CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101
- WEED CONTROL IN CITRICULTURE ...2.0123

Sutan
- CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025

T, 2,4,5-
- LEACHING OF SELECTED HERBICIDES IN ALABAMA SOILS ...1.0001
- RESPROUTING OF CHAPARRAL ...1.0017
- PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023
- SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065
- MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...1.0071
- BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083
- PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0084
- PESTICIDE RESIDUES IN KANSAS STREAMS ...1.0150
- LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...1.0212
- TOXICITY OF POLLUTANTS TO STRIPED BASS ...1.0251
- WEED CONTROL IN RICE PRODUCTION ...2.0097
- WEED CONTROL IN RICE PRODUCTION ...2.0098

Tandex
- WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...1.0005
- RESPROUTING OF CHAPARRAL ...1.0017

TCA
- ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106
- PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105
- RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...2.0161

Tenoran
- CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101

Terbacil
- CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025
- WEED CONTROL IN CITRICULTURE ...2.0123
- CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187

TOK
- WEED CONTROL IN RICE PRODUCTION ...2.0097

Trifluralin
- INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0002
- INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008
- EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010
- THE DISPOSITION OF PESTICIDES IN THE SOIL ...1.0030
- DISPOSITION OF PESTICIDES IN THE SOIL ...1.0031
- PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...1.0075
- BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0091
- PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...1.0094
- MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099
- ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106
- CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...1.0189
- WEED CONTROL IN CITRICULTURE ...2.0123
- ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

Vcs 438
- WEED CONTROL IN CITRICULTURE ...2.0123

Xylene
- PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105
- CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...2.0178

Insect Chemosterilants

- CONTROL OF COMMON HOUSEFLY ...2.0005
- INVESTIGATIONS OF PHEROMONES AS CHEMOSTERILANTS FOR INSECTS WITH SPECIAL REFERENCE TO SYNTHETIC QUEN SUBSTANCE AND ITS ANALOGUES ...2.0021
- TESTING ADULT ATTRACTION DEVICES AND CHEMOSTERILANTS FOR TABANID FLY CONTROL ...2.0024
- CONTROL OF CULEX NIGRIPALPUS BY STERILITY METHODS ...2.0032
- BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS ...2.0033
- RADIATION CYTOGENETICS OF THE YELLOW-FEVER MOSQUITO, AEDES AEGYPTI ...2.0036
- BIOLOGICAL EVALUATION OF INSECT CONTROL AGENTS ...2.0050
- BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057

Aziridines, Phosphorous Based
- BIOLOGICAL EVALUATION OF INSECT CONTROL AGENTS ...2.0050

Hempa

INSECT CHEMOSTERILANTS ...2.0049

MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085

Metepa

TESTING ADULT ATTRACTION DEVICES AND CHEMOSTERILANTS FOR TABANID FLY CONTROL ...2.0024

Tepa

INSECT CHEMOSTERILANTS ...2.0049

MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085

Thiotepa

INVESTIGATIONS OF THE ACTION OF CHEMOSTERILANTS ON HOUSEFLIES AND OTHER MEDICALLY IMPORTANT ARTHROPODS ...2.0026

INSECT CHEMOSTERILANTS ...2.0049

Insecticide - Acaricide

Aliphatic Carbamates

FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL ...1.0077

Bayer 37344

BIOLOGY AND CONTROL OF SNAILS ...2.0268

ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

BIOLOGY AND CONTROL OF TERRESTIAL MOLLUSKS ...2.0289

THE CONTROL OF SLUGS ...2.0294

Baytex

ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001

EFFECT OF MOSQUITO CONTROL CHEMICALS ON AQUATIC FAUNA ...2.0003

AERIAL DISPERSAL METHODS FOR CONCENTRATED INSECTICIDES ...2.0009

NEW INSECTICIDES & TECHNIQUES FOR PEST CONTROL ...2.0016

RELATION OF APPLICATION METHODS, CONCENTRATION, AND VOLUME OF INSECTICIDE TO CATTLE INSECT CONTROL ...2.0039

MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...2.0060

THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...2.0079

PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...3.0108

Chlorphenamidine

FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...1.0089

Cythioate

THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078

Demeton

PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES ...1.0062

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0141

Dimethoate

DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215

ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

Dioxathion

DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215

Disulfoton

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0141

Ethion

DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215

Fenazaflor

FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...1.0089

BIOLOGY AND CONTROL OF SNAILS ...2.0268

BIOLOGY AND CONTROL OF TERRESTIAL MOLLUSKS ...2.0289

Paraoxon

INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0043

FATE OF PESTICIDES ...1.0064

Parathion

INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0043

REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0046

PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS ...1.0055

FATE OF PESTICIDES ...1.0064

STUDY OF ELECTROHYDRAULIC WATER TREATMENT ...1.0121

DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...1.0249

THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...1.0253

LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES ...1.0258

EFFECTS OF PARATHION AND MALATHION ON WARM-WATER FISH PONDS ...1.0283

STUDY OF CHRONIC TOXICITY OF LINDANE TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0337

STUDY OF CHRONIC TOXICITY OF PARATHION TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0357

CONTROL OF COMMON HOUSEFLY ...2.0005

NEW INSECTICIDES & TECHNIQUES FOR PEST CONTROL ...2.0016

Phoxim

EVALUATION OF NEW INSECTICIDES ...2.0015

SUPPRESSION AND ECOLOGY OF MOSQUITOES ...2.0018

INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025

ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

Supracide

PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS ...1.0063

SUPPRESSION AND ECOLOGY OF MOSQUITOES ...2.0018

Tetradifon

DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215

Trithion

DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215

Insecticide - Fungicide

Furadan

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0037

THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0144

THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0330

BIOLOGY AND CONTROL OF SNAILS ...2.0268

Vorlex

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...**1.0082**

Insecticide - Piscicide

Thanite

RESIDUES OF THANITE IN FISH MUSCLE ...**1.0314**
THE EFFICACY OF THANITE (ISOBORNYL THIOCYANOACETATE) AS A FISH COLLECTION AID ...**2.0242**
THE EFFECTS OF THANITE ON THE INORGANIC BLOOD CHEMISTRIES OF FISHES ...**2.0253**
THE EFFECTS OF THANITE ON THE ACID-BASE BALANCE IN THE BLOOD OF FISHES ...**2.0254**

Insecticide-antihelminth

Coumaphos

EFFECT OF BITING FLIES ON WEIGHT GAINS IN CATTLE ...**2.0090**
PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...**3.0108**

Zinophos

ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...**2.0288**

Insecticide-fumigant

Chloroform

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...**2.0079**

Hexamethylditin

BIOLOGY AND CONTROL OF TERRESTIAL MOLLUSKS ...**2.0289**

Insecticides

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...**1.0038**
EFFECTS OF INSECTICIDES ON ACTIVITY OF SOIL INHABITING INSECTS ...**1.0059**
MULTI-DISCIPLINARY RESEARCH IN POLLUTION ...**1.0070**
EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...**1.0100**
SOILS, PESTICIDES AND THE QUALITY OF WATER ...**1.0105**
FATE OF INSECTICIDES IN SOIL AND THEIR MOVEMENT IN WATER AND CROPS ...**1.0111**
PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...**1.0143**
MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...**1.0160**
PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...**1.0163**
PRESTICIDE INPUTS AND LEVELS IN MINNESOTA WATERS OF THE LAKE SUPERIOR BASIN ...**1.0167**
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...**1.0168**
PESTICIDE LEVELS IN WATER AND WILDLIFE OF REELFOOT LAKE, TENNESSEE ...**1.0208**
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...**1.0223**
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...**1.0224**
FACTORS AFFECTING PESTICIDE TOXICITY ...**1.0255**
RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...**1.0256**
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...**1.0265**
THYROIDAL I125 UPTAKE IN IMMATURE CHANNEL CATFISH FOLLOWING EXPOSURE TO SELECTED TOXICANTS ...**1.0272**
DEVELOPMENT OF TECHNIQUES FOR IDENTIFICATION OF PESTICIDES AND THEIR METABOLITES BY MASS SPECTROMETRY ...**1.0295**
ACCUMULATION OF PESTICIDES IN MENHADEN ...**1.0299**
PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...**1.0328**
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...**1.0334**
MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS ...**1.0338**
INFLUENCE OF PROTOZOAN ACTIVITY ON HALOGENATED HYDROCARBON RESIDUES - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0349**
THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM ...**1.0350**
PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...**1.0358**
CHEMICAL BIOCIDES IN LAKES ...**1.0364**
INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...**2.0010**
STUDIES ON INSECTICIDE RESISTANCE IN MOSQUITOES ...**2.0017**
SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...**2.0028**
CONTROL OF BLACK FLIES AND MOSQUITOES IN MAINE ...**2.0046**
ABUNDANCE, DISTRIBUTION AND CONTROL OF MISCELLANEOUS INSECTS, AFFECTING LIVESTOCK ...**2.0056**
SURVEY OF INSECT PROBLEMS IN MONTANA ...**2.0059**
MOSQUITO CONTROL - TIDAL MARSHES ...**2.0063**
MOSQUITO CONTROL IN UPLAND SWAMPS ...**2.0065**
CONTROLLING MOSQUITOES ON HAYING MEADOWS ...**2.0066**
STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS ...**2.0067**
INSECTS AFFECTING MAN ...**2.0068**
SUSCEPTIBILITY OR RESISTANCE OF MEDICALLY IMPORTANT INSECTS TO INSECTICIDES ON SELECTED AIR FORCE BASES ...**2.0084**
ROTENOIDS FROM TEPHROSIA VOGELII ...**2.0198**
BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...**4.0058**
LABORATORY ANALYSIS OF INSECTICIDE EFFECTIVENESS AGAINST MEDICALLY IMPORTANT INSECTS ...**4.0068**
RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...**4.0070**

Abate

THE SUSCEPTIBILITY OF VARIOUS LIFE STAGES OF FRESHWATER FISHES TO THREE TOXICANTS ...**1.0279**
EFFECT OF MOSQUITO CONTROL CHEMICALS ON AQUATIC FAUNA ...**2.0003**
INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...**2.0025**
MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...**2.0060**
MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...**2.0062**
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...**2.0079**

Agritox

ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...**2.0288**

Akton

SUPPRESSION AND ECOLOGY OF MOSQUITOES ...**2.0018**

Aldrin

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...**1.0008**
MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS ...**1.0011**
DISPOSITION OF PESTICIDES IN THE SOIL ...**1.0031**
REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0046**
REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...**1.0047**
PESTICIDE RESIDUES IN KANSAS STREAMS ...**1.0150**
PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...**1.0170**
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...**1.0191**
CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...**1.0205**
PESTICIDE MONITORING PROGRAM ...**1.0238**

THE EFFECT OF DIELDRIN ON SURVIVAL AND DEVELOPMENT OF FISH EGGS ...**1.0300**

STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970 ...**1.0354**

ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...**2.0089**

Azodrin

REDUCTION OF PESTICIDE RESIDUE HAZARDS ...**1.0040**

Baygon

INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...**2.0025**

RELATION OF APPLICATION METHODS, CONCENTRATION, AND VOLUME OF INSECTICIDE TO CATTLE INSECT CONTROL ...**2.0039**

EMERGENCY INSECT CONTROL ...**2.0076**

NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...**2.0077**

PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...**3.0108**

BHC

PESTICIDE RESIDUES IN KANSAS STREAMS ...**1.0150**

PESTICIDE MONITORING PROGRAM ...**1.0238**

PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES ...**1.0306**

Chlordan

PESTICIDE RESIDUES IN KANSAS STREAMS ...**1.0150**

PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...**1.0170**

MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...**1.0266**

THE SUSCEPTIBILITY OF VARIOUS LIFE STAGES OF FRESHWATER FISHES TO THREE TOXICANTS ...**1.0279**

EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - ORGANOCHLORINE PESTICIDES AND DISEASE RESISTANCE MECHANISMS OF RAINBOW TROUT ...**1.0312**

INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0351**

BIODEGRADATION OF PESTICIDES IN A FRESHWATER ECOSYSTEM - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0352**

EMERGENCY INSECT CONTROL ...**2.0076**

Chlorphoxoxim

SUPPRESSION AND ECOLOGY OF MOSQUITOES ...**2.0018**

Ciodrin

LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...**1.0212**

D D V P

NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...**2.0077**

DDE

PESTICIDE RESIDUES ON ARIZONA CROPS ...**1.0007**

CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...**1.0024**

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0037**

REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0046**

FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL ...**1.0077**

PESTICIDE RESIDUES IN KANSAS STREAMS ...**1.0150**

CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...**1.0205**

PESTICIDES RESEARCH ...**1.0232**

PESTICIDE MONITORING PROGRAM ...**1.0238**

QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...**1.0259**

INVESTIGATION OF MEANS FOR CONTROLLED SELF-DESTRUCTION OF PESTICIDES ...**1.0323**

ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...**1.0339**

EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS ...**1.0341**

TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...**1.0344**

SELECTED PESTICIDES IN AQUATIC FUNGI IN THE THREE RIVERS AREA ...**1.0345**

STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...**4.0022**

DDT

PESTICIDE RESIDUES ON ARIZONA CROPS ...**1.0007**

MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS ...**1.0011**

DEVELOPMENT OF A TECHNIQUE FOR THE CONTROLLED SELF-DESTRUCTION OF FIELD-APPLIED DDT ...**1.0014**

ANALYTICAL METHODS FOR PESTICIDES IN SOIL AND WATER ...**1.0018**

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...**1.0019**

REACTIONS OF PESTICIDES WITH SOILS ...**1.0020**

CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...**1.0024**

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...**1.0029**

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...**1.0032**

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0037**

REDUCTION OF PESTICIDE RESIDUE HAZARDS ...**1.0040**

REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...**1.0047**

WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...**1.0050**

CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...**1.0051**

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...**1.0052**

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...**1.0053**

PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS ...**1.0055**

TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...**1.0056**

PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES ...**1.0062**

ENVIRONMENTAL BIOLOGY - BIOGEOCHEMICAL CYCLING IN ECOLOGICAL SYSTEMS ...**1.0068**

PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...**1.0075**

FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL ...**1.0077**

THE CYCLING OF CL-36 LABELED DDT IN NATURAL ECOSYSTEMS ...**1.0078**

BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...**1.0083**

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0097**

MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...**1.0098**

ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN ...**1.0132**

PESTICIDE RESIDUES IN KANSAS STREAMS ...**1.0150**

A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...**1.0168**

PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...**1.0170**

SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...**1.0181**

CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...**1.0189**

CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...**1.0205**

LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...**1.0212**

DDT IN SNOW FALLEN AT HIGH ALTITUDE SINCE 1950 ...**1.0214**

TERMINAL RESIDUES OF CHLORINATED HYDROCARBON PESTICIDES IN LAKE MICHIGAN AND ASSOCIATED TRIBUTARIES ...**1.0222**

PESTICIDES RESEARCH ...**1.0232**

PESTICIDE MONITORING PROGRAM ...**1.0238**

PHYSIOLOGY OF ESTUARINE ORGANISMS ...**1.0242**

RELATIONSHIPS BETWEEN SUB-LETHAL PESTICIDES AND REPRODUCTION AND BEHAVIOR OF FISHES ...**1.0245**

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...**1.0249**

PESTICIDE CONTAMINATION OF ENVIRONMENT ...**1.0250**

TOXICITY OF POLLUTANTS TO STRIPED BASS ...**1.0251**

EFFECTS OF CHRONIC SUBLETHAL DOSAGES OF DDT ON THE SWIMMING PERFORMANCE OF ATLANTIC SALMON PARR ...**1.0252**

PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES ...**1.0254**

QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...**1.0259**

BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH ...**1.0261**

MAGNITUDE AND NATURE OF POLYCHLORINATED BIPHENYLS IN COHO SALMON ...**1.0262**

MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...**1.0266**

INVESTIGATION OF STRESS-INDUCED MOBILIZATION OF INSECTICIDE RESIDUES - CHRONIC TOXICITY OF PESTICIDES TO FISH ...**1.0281**

CHRONIC TOXICITY OF PESTICIDES TO FISH ...**1.0287**

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0288**

THE RELATIONSHIP BETWEEN THE USE OF AGRICULTURAL CHLORINATED HYDROCARBONS AND THEIR RESIDUES IN CHANNEL CATFISH ...**1.0298**

PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES ...**1.0306**

INHIBITORY EFFECT OF DDT IN ATPASE ASSAY MIXTURES ...**1.0309**

ELIMINATE OR REDUCE EFFECTS OF PESTICIDE RESIDUES ...**1.0311**

EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - ORGANOCHLORINE PESTICIDES AND DISEASE RESISTANCE MECHANISMS OF RAINBOW TROUT ...**1.0312**

SUBLETHAL AMOUNTS OF ORGANIC INSECTICIDES AND FISH ...**1.0313**

INVESTIGATION OF MEANS FOR CONTROLLED SELF-DESTRUCTION OF PESTICIDES ...**1.0323**

IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS ...**1.0335**

AN INVESTIGATION OF THE EFFECTS OF DDT AND OTHER CHLORINATED HYDROCARBONS ON THE GROWTH OF EURYHALINE MICROALGAE ...**1.0336**

ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...**1.0339**

EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS ...**1.0341**

SELECTED PESTICIDES IN AQUATIC FUNGI IN THE THREE RIVERS AREA ...**1.0345**

STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970 ...**1.0354**

INTERCEPTION AND DEGRADATION OF PESTICIDES BY AQUATIC ALGAE ...**1.0363**

THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...**1.0365**

PESTICIDE LEVELS IN BIRDS WINTERING ON LAKE MICHIGAN ...**1.0367**

INSECTICIDES AND EGG-SHELL DEPOSITION ...**1.0368**

MALARIA ERADICATION RESEARCH ...**2.0051**

MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...**2.0060**

LEGAL REPRESENTATION OF CITIZEN'S INTERESTS IN ENVIRONMENTAL PROTECTION ...**2.0069**

ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...**2.0089**

MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...**2.0124**

ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...**2.0288**

STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...**4.0022**

Diazinon

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0037**

REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0046**

FATE OF PESTICIDES ...**1.0064**

THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...**1.0144**

MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...**1.0266**

INSECTS AFFECTING MAN AND ANIMALS ...**2.0081**

ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...**2.0288**

Diazoxon

FATE OF PESTICIDES ...**1.0064**

Dibrom

INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...**2.0025**

RELATION OF APPLICATION METHODS, CONCENTRATION, AND VOLUME OF INSECTICIDE TO CATTLE INSECT CONTROL ...**2.0039**

INSECTS AFFECTING MAN AND ANIMALS ...**2.0081**

Dieldrin

MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS ...**1.0011**

REACTIONS OF PESTICIDES WITH SOILS ...**1.0020**

REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...**1.0021**

CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...**1.0024**

DISPOSITION OF PESTICIDES IN THE SOIL ...**1.0031**

PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...**1.0033**

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0037**

REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0046**

REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...**1.0047**

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...**1.0053**

CONTROL OF PESTICIDES IN SOIL AND WATER ...**1.0054**

PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS ...**1.0055**

TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...**1.0056**

RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS ...**1.0138**

PESTICIDE RESIDUES IN KANSAS STREAMS ...**1.0150**

PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...**1.0170**

SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...**1.0181**

RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION ...**1.0194**

CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...**1.0205**

TERMINAL RESIDUES OF CHLORINATED HYDROCARBON PESTICIDES IN LAKE MICHIGAN AND ASSOCIATED TRIBUTARIES ...**1.0222**

PESTICIDE MONITORING PROGRAM ...**1.0238**

EFFECTS OF PESTICIDES ON MARINE ANIMALS ...**1.0244**

CONTAMINATION OF CHANNEL CATFISH WITH DIELDRIN FROM AGRICULTURAL RUNOFF ...1.0247
PESTICIDE CONTAMINATION OF ENVIRONMENT ...1.0250
PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES ...1.0254
PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260
BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH ...1.0261
PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269
INVESTIGATION OF STRESS-INDUCED MOBILIZATION OF INSECTICIDE RESIDUES - CHRONIC TOXICITY OF PESTICIDES TO FISH ...1.0281
CHRONIC TOXICITY OF PESTICIDES TO FISH ...1.0287
PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0288
THE RELATIONSHIP BETWEEN THE USE OF AGRICULTURAL CHLORINATED HYDROCARBONS AND THEIR RESIDUES IN CHANNEL CATFISH ...1.0298
THE EFFECT OF DIELDRIN ON SURVIVAL AND DEVELOPMENT OF FISH EGGS ...1.0300
THE UPTAKE OF DIELDRIN IN THE THREE RIDGED NAIAD, AMBLEMA PLICATA ...1.0301
EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS ...1.0341
PHARMACOLOGICAL AND ECOLOGICAL EFFECTS OF PESTICIDES ...1.0362
INTERCEPTION AND DEGRADATION OF PESTICIDES BY AQUATIC ALGAE ...1.0363
ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089

Dipterex
TOXICITY OF POLLUTANTS TO STRIPED BASS ...1.0251
RELATION OF APPLICATION METHODS, CONCENTRATION, AND VOLUME OF INSECTICIDE TO CATTLE INSECT CONTROL ...2.0039

Dursban
CHRONIC EFFECTS OF DURSBAN ON WARM-WATER FISH ...1.0282
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0304
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0305
PESTICIDES AND WILDLIFE ...1.0324
CONTROL OF COMMON HOUSEFLY ...2.0005
BIOLOGY AND CONTROL OF PASTURE MOSQUITOES ...2.0008
AERIAL DISPERSAL METHODS FOR CONCENTRATED INSECTICIDES ...2.0009
MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...2.0060
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...2.0079

Endrin
ANALYTICAL METHODS FOR PESTICIDES IN SOIL AND WATER ...1.0018
RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019
CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...1.0024
DISPOSITION OF PESTICIDES IN THE SOIL ...1.0031
REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0046
ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS ...1.0049
WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...1.0050
METABOLISM OF ENDRIN IN PONDS ...1.0113
STUDY OF ELECTROHYDRAULIC WATER TREATMENT ...1.0121
PESTICIDE RESIDUES IN KANSAS STREAMS ...1.0150
CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...1.0205
EFFECT OF ENDRIN ON EGG-SPERM FORMATION AND EMBRYONIC DEVELOPMENT ...1.0229
EFFECT OF ENDRIN ON FISH AND THEIR ENVIRONMENT UNDER CONTROLLED CONDITIONS ...1.0230
PRELIMINARY STUDIES ON ENDRIN AND OTHER PESTICIDE UPTAKES BY FINGERLING CHANNEL CATFISH ...1.0231
CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...1.0235
PESTICIDE MONITORING PROGRAM ...1.0238
PESTICIDE CONTAMINATION OF ENVIRONMENT ...1.0250
TOXICITY OF POLLUTANTS TO STRIPED BASS ...1.0251
LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES ...1.0258
PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269

Ethyl Parathion
EFFECT OF MOSQUITO CONTROL CHEMICALS ON AQUATIC FAUNA ...2.0003

Gardona
ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001
CONTROL OF COMMON HOUSEFLY ...2.0005
THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...2.0078

Guthion
DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215
PESTICIDE CONTAMINATION OF ENVIRONMENT ...1.0250
BIOLOGY AND CONTROL OF SNAILS ...2.0268

Heptachlor
CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...1.0024
REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0046
CONTROL OF PESTICIDES IN SOIL AND WATER ...1.0054
PESTICIDE RESIDUES IN KANSAS STREAMS ...1.0150
SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...1.0181
CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...1.0205
PESTICIDE MONITORING PROGRAM ...1.0238
PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES ...1.0254
CONTROL OF COMMON HOUSEFLY ...2.0005

Heptachlor Epoxide
CONTROL OF PESTICIDES IN SOIL AND WATER ...1.0054
CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...1.0205
PESTICIDE MONITORING PROGRAM ...1.0238

Isodrin
PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...1.0170

Lindane
MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS ...1.0011
REACTIONS OF PESTICIDES WITH SOILS ...1.0020
REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...1.0021
CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...1.0024
PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...1.0032
PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...1.0033
RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS ...1.0138
PESTICIDE RESIDUES IN KANSAS STREAMS ...1.0150
PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...1.0170

CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...**1.0205**
PESTICIDE MONITORING PROGRAM ...**1.0238**
STUDY OF CHRONIC TOXICITY OF LINDANE TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...**1.0337**

Malathion
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0076**
DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...**1.0215**
LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES ...**1.0258**
EFFECTS OF PARATHION AND MALATHION ON WARM-WATER FISH PONDS ...**1.0283**
MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...**1.0292**
TOXICITY OF SELECTED METALS TO CONDITIONED FISH ...**1.0302**
ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...**2.0001**
EFFECT OF MOSQUITO CONTROL CHEMICALS ON AQUATIC FAUNA ...**2.0003**
CONTROL OF COMMON HOUSEFLY ...**2.0005**
BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...**2.0006**
BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...**2.0040**
COORDINATION OF MOSQUITO CONTROL IN NEW JERSEY ...**2.0061**
MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...**2.0062**
INSECTS AFFECTING MAN AND ANIMALS ...**2.0081**
EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...**2.0082**
EFFECT OF BITING FLIES ON WEIGHT GAINS IN CATTLE ...**2.0090**

MCA 600
FATE OF PESTICIDES ...**1.0064**

Methomyl
BIOLOGY AND CONTROL OF SNAILS ...**2.0268**

Methoxychlor
REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0037**
CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...**1.0051**
THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...**1.0144**
PESTICIDE MONITORING PROGRAM ...**1.0238**
FIELD STUDIES OF PESTICIDE EFFECTS ON FISHES ...**1.0257**
PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...**1.0260**
STREAM STUDIES TO DETERMINE TOXIC EFFECTS OF METHOXYCHLOR IN FISH POPULATIONS ...**1.0263**
LABORATORY BIOASSAYS TO DETERMINE TOXIC EFFECS OF METHOXYCHLOR IN FISH ...**1.0264**
SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0273**
METHOXYCHLOR-CAUSED EFFECTS ON CUTTHROAT TROUT PHYSIOLOGY - CHRONIC TOXICITY OF INSECTICIDES TO COLD-WATER FISH ...**1.0296**
INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0351**
ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...**2.0001**
EFFECTS OF METHOXYCHLOR ON THE CONDITIONING OF STRIPED BASS TO AN OLFACTORY STIMULUS ...**2.0233**

Methyl Parathion
REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0046**
PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS ...**1.0063**
TOXICITY OF POLLUTANTS TO STRIPED BASS ...**1.0251**
THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...**1.0365**
EMERGENCY INSECT CONTROL ...**2.0076**

Monitor
EVALUATION OF NEW INSECTICIDES ...**2.0015**

Paris Green
MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...**2.0062**

Pyrethrum
MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...**1.0266**
BIOLOGICAL EVALUATION OF INSECT CONTROL AGENTS ...**2.0050**

Ronnel
REDUCTION OF PESTICIDE RESIDUE HAZARDS ...**1.0040**
PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...**3.0108**

Ruelene
THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...**2.0078**
PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...**3.0108**

Sevin
AN EVALUATION OF THE INSECTICIDE 'SEVIN' AS A WATERSHED POLLUTANT ...**1.0067**
PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...**1.0087**
LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES ...**1.0258**
UPTAKE, PERSISTENCE AND METABOLITES OF SEVIN BY CHANNEL CATFISH ...**1.0284**
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...**1.0304**
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...**1.0305**
NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...**2.0077**

Sumithion
IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS ...**1.0335**

TDE
CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...**1.0024**
WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...**1.0050**
FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL ...**1.0077**
CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...**1.0205**
PESTICIDES RESEARCH ...**1.0232**
PESTICIDE MONITORING PROGRAM ...**1.0238**
QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...**1.0259**
ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...**1.0339**
TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...**1.0344**
SELECTED PESTICIDES IN AQUATIC FUNGI IN THE THREE RIVERS AREA ...**1.0345**

Thimet
BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...**1.0083**
MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...**1.0266**

Thiodan
CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...1.0051
EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - ORGANOCHLORINE PESTICIDES AND DISEASE RESISTANCE MECHANISMS OF RAINBOW TROUT ...1.0312

Thuricide
EMERGENCY INSECT CONTROL ...2.0076

Toxaphene
PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...1.0032
PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES ...1.0062
PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...1.0075
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0097
MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...1.0098
TOXAPHENE CONTAMINATION - ESTUARINE ECOLOGY ...1.0139
PESTICIDE RESIDUES IN KANSAS STREAMS ...1.0150
CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...1.0189
CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...1.0205
EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...1.0249
INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0351
BIODEGRADATION OF PESTICIDES IN A FRESHWATER ECOSYSTEM - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0352

UC 30045
ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

Iodides
EFFECTIVENESS OF IODINE FOR DISINFECTION OF PUBLIC WATER SUPPLIES & TO DETERMINE PHYSIOLOGICAL EFFECTS ON A HUMAN POPULATION ...1.0126
EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

Metal Organics -nonspecific
BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053
CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086
CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...1.0235
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0129

Molluscicides
CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101
CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266
BIOLOGY AND CONTROL OF SNAILS ...2.0268
THE BIOLOGY AND CONTROL OF THE SNAIL INTERMEDIATE HOST OF SCHISTOSOMES ...2.0276
INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...2.0280
BIOLOGY AND CONTROL OF TERRESTRIAL MOLLUSCS ...2.0281
'A METHOD OF DESTROYING ONCOMELANIA-THE SNAIL VECTOR OF SCHISTOSOMIASIS' ...2.0284
DEVELOPMENT OF A TOXIC BAIT ...2.0286
CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER ...2.0290
MOLLUSCICIDES - A CORRELATION OF STRUCTURE VS. ACTIVITY ...2.0291
OYSTER DRIL (OCINEBRA JAPONICA) CONTROL ...2.0293
THE CONTROL OF SLUGS ...2.0294

Bayluscide
METHOD OF KILLING ONCOMELANIA & AQUATIC SNAIL VECTORS OF SCHISTOSOMIASIS ...2.0285

Tributyltin Cpds
CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266
METHOD OF KILLING ONCOMELANIA & AQUATIC SNAIL VECTORS OF SCHISTOSOMIASIS ...2.0285

Triphenyllead Cpds.
METHOD OF KILLING ONCOMELANIA & AQUATIC SNAIL VECTORS OF SCHISTOSOMIASIS ...2.0285

Multiple Usage

Pentachlorophenol
PHARMACOLOGICAL AND ECOLOGICAL EFFECTS OF PESTICIDES ...1.0362
MARINE PILING ANALYSIS ...2.0296

Sodium Arsenite
FARM FISH POND MANAGEMENT ...1.0340
AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...1.0343

Organophosphorous Cpds.
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0038
EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041
ANALYSIS OF PESTICIDE RESIDUES ...1.0058
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105
FLUORESCENT PROBES IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS FOR WATER POLLUTION ...1.0137
RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0168
RAPID DETECTION OF TOXIC MATERIALS IN WATER ...1.0180
AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...1.0186
QUANTITATIVE METHODS FOR PESTICIDES IN NATURAL WATERS ...1.0198
TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE ...1.0201
PESTICIDE LEVELS IN WATER AND WILDLIFE OF REELFOOT LAKE, TENNESSEE ...1.0208
OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...1.0219
ATOMIC ABSORPTION ANALYSIS OF PHOSPHATES IN WATER ...1.0227
CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...1.0235
ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...1.0239
PESTICIDE CONTAMINATION OF ENVIRONMENT ...1.0250
FACTORS AFFECTING PESTICIDE TOXICITY ...1.0255
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0334
IN VITRO POTENCY OF SEVERAL ANTICHOLINESTERASE AGENTS WITH SELECTED MEMBERS OF THE AQUATIC ENVIRONMENT ...1.0348
RESPIRATION RATES OF FISH-FOOD INVERTEBRATES EXPOSED TO PESTICIDES ...1.0355
BIOLOGY AND CONTROL OF PASTURE MOSQUITOES ...2.0008
EVALUATION OF NEW INSECTICIDES ...2.0015
STUDIES ON INSECTICIDE RESISTANCE IN MOSQUITOES ...2.0017
SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...2.0055

SELECTIVE TOXICITY BY OPTICALLY ACTIVE PHOSPHONOTHIONATE PESTICIDES ...2.0086
ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089
DEVELOPMENT OF CULTURE METHODS FOR MOSQUITOES ...4.0035

Pesticides -nonspecific

SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL ...1.0012
VOLATILIZATION LOSSES OF PESTICIDES FROM SOILS ...1.0016
BEHAVIOR OF POLLUTANTS IN WATER ...1.0022
ECONOMIC EFFECTS OF PESTICIDES AND OTHER WASTES ON NATURAL RESOURCE QUALITY ...1.0026
MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS ...1.0028
POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...1.0036
RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...1.0057
METHODS FOR DISPOSAL OF SPILLED AND UNUSED PESTICIDES ...1.0060
SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...1.0066
EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...1.0074
EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS ...1.0080
FATES OF AGRICULTURAL CHEMICALS IN SOILS ...1.0092
CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0093
EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...1.0100
EFFECT OF PESTICIDES ON THE QUALITY OF SURFACE AND GROUND WATERS IN THE WESTERN GULF REGION ...1.0101
DEVELOPMENT OF ON-SITE BIOASSAY METHODS ...1.0108
INTERFERING SOIL CONSTITUENTS IN DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND WATER ...1.0109
IDENTIFICATION AND DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND RUNOFF AND DRAINAGE WATERS. ...1.0110
PHOTOCHEMICAL METHODS FOR PURIFYING WATER ...1.0115
INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0116
AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117
ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120
PREDICTING MINERAL QUALITY OF RETURN FLOW WATER ...1.0122
IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD ...1.0123
ATTENTION AND RUNOFF OF PESTICIDES FROM AGRICULTURAL LANDS TO SURFACE WATERS ...1.0124
PESTICIDE KINETICS ...1.0127
ESTUARINE ECOSYSTEMS ...1.0128
ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT ...1.0131
EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133
UPPER ST. JOHNS RIVER BASIN WATER QUALITY, FLORIDA ...1.0134
RURAL RUNOFF CONTROL ...1.0135
DEVELOP EFFECTIVE TREATMENT METHODS FOR HARD PESTIDICIDES ...1.0136
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0140
STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES ...1.0142
GREAT LAKES PESTICIDE MONITORING PROGRAM, INDIANA ...1.0147
DETECTION AND IDENTIFICATION OF MOLECULAR WATER POLLUTANTS BY LASER RAMAN SPECTROSCOPY ...1.0151
ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...1.0153
POLLUTION LOADS IN RUNOFF FROM SMALL AGRICULTURAL WATERSHEDS ...1.0154
PESTICIDE MONITORING PROGRAM ...1.0156
MASSACHUSETTS PESTICIDE MONITORING STUDY ...1.0157
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0158
AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161
WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...1.0162
PESTICIDE TESTING FOR SETTING STANDARDS ...1.0165
PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166
DEVELOP IN-HOUSE CAPABILITY IN WATER QUALITY TECHNIQUES FOR ANALYSES OF HEAVY METALS, BACTERIA, AND PESTICIDE RESIDUES ...1.0171
SERVICES FOR THE QUANTITATIVE ANALYSIS OF PESTICIDES IN SEAWATER AND BIOLOGICAL SAMPLES ...1.0172
PREPARATION OF CHLORINE-36 LABELED ORGANOCHLORINE PESTICIDES AND RELATED COMPOUNDS (PCB'S) ...1.0174
UPDATING THE 'HANDBOOK OF PROCEDURES FOR PESTICIDE RESIDUE ANALYSIS' - METHODOLOGY IN CHEMICAL ANALYSIS AND SAMPLING ...1.0176
THE EFFECTS OF HERBICIDES, PESTICIDES, AND FERTILIZERS ON THE OPTICAL PROPERTIES OF WATER ...1.0177
LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION ...1.0178
GROUND AND SURFACE WATERS - POLLUTION ...1.0182
DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183
DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...1.0184
CONCENTRATION AND ANALYSIS OF PESTICIDES AND OTHER RECALCITRANT MOLECULES IN WATER SUPPLIES BY ULTRAFILTRATION ...1.0185
QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187
CHROMATOGRAPHIC CONCENTRATION OF PESTICIDES FROM A LARGE MASS OF WATER ...1.0188
CENTER FOR STUDY OF THE HUMAN ENVIRONMENT ...1.0190
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0192
PESTICIDES MOVEMENT FROM CROPLAND INTO LAKE ERIE ...1.0193
MICROWAVE-EXCITED EMISSION DETECTOR FOR PESTICIDES AND TRACE METAL ANALYSIS ...1.0195
DEVELOP EFFECTIVE TREATMENT METHODS FOR HARD PESTICIDES ...1.0197
PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...1.0199
THE BIOASSAY OF WATER POLLUTANTS WITH CULTURED MAMMALIAN CELLS ...1.0200
FISHERIES UNIT ...1.0203
QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204
DESIGNING A GLOBAL ENVIRONMENTAL MONITORING SYSTEM ...1.0206
INVESTIGATION OF RICE IRRIGATION RETURN FLOWS - TEXAS COASTAL PRAIRIE REGION ...1.0209
CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0210
ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211
PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN ...1.0213
IMPROVING WATER QUALITY BY REMOVAL OF PESTICIDE POLLUTANTS WITH AQUATIC PLANTS ...1.0216
SOURCES OF QUALITY IMPAIRMENT OF SURFACE WATERS ...1.0218
THE OCCURRENCE OF PESTICIDE RESIDUES IN THE LOWER BRISBANE RIVER AND IN THE TISSUES OF ESTUARINE ANIMALS ...1.0233

EFFECTS OF PESTICIDES ON AQUATIC ANIMALS IN THE ESTUARINE AND MARINE ENVIRONMENTS ...**1.0234**
PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...**1.0236**
BEHAVIOR OF ESTUARINE ANIMALS ...**1.0240**
LABORATORY BIOASSAYS ...**1.0241**
PHYSICAL AND CHEMICAL FACTORS AFFECTING FISH ...**1.0246**
EFFECTS ON THE SPERMIATION RESPONSE OF GOLDFISH AFTER EXPOSURE TO SELECTED PESTICIDES ...**1.0270**
COMPARISON OF METHODS USED TO MEASURE ESTERASE ACTIVITY. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...**1.0274**
SEASONAL CHANGES IN ESTERASE ACTIVITY IN FISH AND INVERTEBRATES. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...**1.0275**
CHARACTERIZATION OF ESTERASE(S) PRESENT IN FISH BLOOD ...**1.0276**
SCREENING OF PESTICIDES AGAINST FISH AT COLUMBIA MISSOURI ...**1.0277**
THE INFLUENCES OF ENVIRONMENTAL CONDITIONS ON THE TOXICITY OF PESTICIDES ...**1.0278**
CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...**1.0285**
PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...**1.0289**
PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...**1.0290**
PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0291**
CONTINUOUS-FLOW BIOASSAY OF PESTICIDES TO EVALUATE THE ACUTE AND CHRONIC EFFECTS OF PESTICIDES TO FRESHWATER INVERTEBRATES ...**1.0294**
THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...**1.0297**
PESTICIDE TOXICITY TO MARINE FISH AND INVERTEBRATES ...**1.0307**
EFFECT OF PESTICIDE RESIDUES ON GAME FISH POPULATIONS ...**1.0310**
REPRODUCTIVE PERFORMANCE OF FISH-EATING BIRDS IN NORTHERN CALIFORNIA ...**1.0320**
THE CHEMISTRY AND TOXICOLOGY OF AGRICULTURAL CHEMICALS ...**1.0322**
SELECTED PESTICIDES VS. WILDLIFE IN AQUATIC ENVIRONMENTS ...**1.0325**
CONSTRUCTION OF PESTICIDES DEGRADABLE BY NORMAL MICROFLORA OF NATURAL WATERS AND SOILS ...**1.0331**
ILLINOIS LAWS AFFECTING AGRICULTURE ...**1.0332**
DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...**1.0333**
BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...**1.0342**
TOXICOLOGY OF PESTICIDES IN THE ENVIRONMENT ...**1.0360**
ENVIRONMENTAL TOXICOLOGY OF PESTICIDES ...**1.0361**
AQUICULTURE, OYSTER HATCHERIES - RESEARCH ...**3.0118**
ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...**4.0007**
INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...**4.0027**
LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN ...**4.0082**

Pesticides -other

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0034**
HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...**1.0035**
PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS ...**1.0063**
FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...**1.0089**
BIOLOGY AND CONTROL OF PASTURE MOSQUITOES ...**2.0008**
EVALUATION OF NEW INSECTICIDES ...**2.0015**
SUPPRESSION AND ECOLOGY OF MOSQUITOES ...**2.0018**
INSECT CHEMOSTERILANTS ...**2.0049**
BIOLOGICAL EVALUATION OF INSECT CONTROL AGENTS ...**2.0050**
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...**2.0079**
WEED CONTROL IN RICE PRODUCTION ...**2.0097**
WEED CONTROL IN RICE PRODUCTION ...**2.0098**
WEED CONTROL IN CITRICULTURE ...**2.0123**
THE USE OF FLAME FOR CONTROLLING WEEDS AND BRUSH ...**2.0136**
SOUAWFISH STUDIES--ST. JOE RIVER, IDAHO ...**2.0196**
FISH TOXICANT STUDIES ...**2.0232**
THE EFFICACY OF MONSANTO NO. 51294 AS A FISH TOXICANT (LABORATORY) ...**2.0243**
BIOLOGY AND CONTROL OF SNAILS ...**2.0268**
BIOLOGY AND CONTROL OF TERRESTIAL MOLLUSKS ...**2.0289**
THE CONTROL OF SLUGS ...**2.0294**
EFFECT OF PRETREATMENT MOLDING OF SOUTHERN PINE ON THE PERMANENCE OF THE PRESERVATIVE IN SEAWATER EXPOSURE ...**2.0295**
CONTROL OF VIBRIOSIS IN SALMON ...**3.0117**
EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...**3.0119**
CHEMOTHERAPY OF FISH DISEASES ...**3.0127**
DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...**4.0051**
LIFE HISTORY OF ST. JOE RIVER CUTTHROAT TROUT ...**4.0077**

Petroleum Cpds. -nonspecific

DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...**1.0196**
INFLUENCE OF PROTOZOAN ACTIVITY ON HALOGENATED HYDROCARBON RESIDUES - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0349**
EFFECT OF MOSQUITO CONTROL CHEMICALS ON AQUATIC FAUNA ...**2.0003**
SUPPRESSION AND ECOLOGY OF MOSQUITOES ...**2.0018**
INVESTIGATIONS OF PHEROMONES AS CHEMOSTERILANTS FOR INSECTS WITH SPECIAL REFERENCE TO SYNTHETIC QUEN SUBSTANCE AND ITS ANALOGUES ...**2.0021**
MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...**2.0060**
MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...**2.0062**
AROMATIC SOLVENT AQUATIC HERBICIDES AND EMULSIFYING AGENT TESTING ...**2.0107**
BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0115**
EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...**2.0267**

Phosphorothioate Cpds.

EVALUATION OF NEW INSECTICIDES ...**2.0015**

Piscicides

Antimycin A

TOXICITY OF POLLUTANTS TO STRIPED BASS ...**1.0251**
THE SUSCEPTIBILITY OF VARIOUS LIFE STAGES OF FRESHWATER FISHES TO THREE TOXICANTS ...**1.0279**
STUDY ON THE EFFECTS OF FISH TOXICANTS ANTIMYCIN A AND ROTENONE ON POND COMMUNITIES ...**1.0366**
RESTORING 'BALANCE' WITH ROTENONE AND FINTROL ...**2.0194**
EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP, SOFT-WATER LAKES ...**2.0213**
EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP SOFTWATER LAKES ...**2.0216**
PISCICIDE TOXICOLOGY OF THE CYPRINIDS IN EAST AND WEST PAULINA LAKES ...**2.0228**
EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT) ...**2.0229**

EVALUATE FISH TOXICANT (ANTIMYCIN) (EAGLE LAKE SEGMENT) ...2.0230

SELECTIVE REMOVAL OF VARIOUS FISH SPECIES WITH ANTIMYCIN ...2.0240

INTENSIVE SCREENING OF POTENTIAL FISH CONTROL AGENTS - POTENTIATION OF ANTIMYCIN ...2.0241

THE EFFICACY AND PERSISTENCE OF FORMULATIONS OF ANTIMYCIN ...2.0244

THE EFFICACY OF NEW FORMULATIONS OF ANTIMYCIN IN NATURAL LAKES AND STREAMS ...2.0246

ESTABLISH MINIMUM DOSES OF ANTIMYCIN AND ROTENONE NEEDED FOR TOTAL KILLS OF TARGET FISHES ...2.0247

EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH ...2.0260

THE EFFECTS OF ANTIMYCIN A ON THE METABOLISM OF SELECTED TISSUES IN FISH (ABBREV) ...2.0262

CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS ...2.0265

REFINEMENT OF MANAGEMENT TECHNIQUES FOR STREAM TROUT LAKES ...3.0035

RENOVATION OF TROUT STREAMS ...4.0076

REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES ...4.0083

MS 222

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260

STUDIES OF SHARK REPELLENTS AND OTHER ANTISHARK MEASURES ...2.0191

EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...2.0234

RESIDUES OF MS-222 IN FISH ...2.0236

THE EFFICACY OF QUINALDINE SULFATE - MS-222 AS AN ANESTHETIC FOR FISH IN THE LABORATORY - WARM SPRINGS ...2.0239

ROUTE(S) OF EXCRETION OF QUINALDINE SULFATE, A FISH ANESTHETIC ...2.0249

METABOLISM AND EXCRETION OF TFM ...2.0251

INVESTIGATION OF HANDLING TECHNIQUES ...3.0111

TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS ...3.0112

Piscicides -nonspecific

DEVELOPMENT OF ON-SITE BIOASSAY METHODS ...1.0108

EXPERIMENTAL USE OF PESTICIDES FOR FISHERIES MANAGEMENT PURPOSES ...2.0189

SQUAWFISH STUDIES--ST. JOE RIVER, IDAHO ...2.0196

SEA LAMPREY CONTROL - LAKE MICHIGAN CHEMICAL CONTROL ...2.0203

SEA LAMPREY CONTROL - LAKE HURON CHEMICAL CONTROL ...2.0204

LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...2.0205

SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...2.0206

SEA LAMPREY CONTROL - REESTABLISHMENT STUDIES ...2.0207

SEA LAMPREY CONTROL - ASSESSMENT METHODS ...2.0208

BIOLOGY OF THE LARVAL SEA LAMPREY ...2.0210

BIOASSAY ...2.0211

EXPERIMENTAL ESTABLISHMENT OF MONOSPECIFIC WALLEYE POPULATIONS AS A MANAGEMENT MEASURE FOR SMALL WARMWATER LAKES IN NORTHERN MINNESOTA ...2.0214

FISH TOXICANT STUDIES ...2.0232

U.V. SPECTROPHOTOMETRY FOR THE IDENTIFICATION AND ESTIMATION OF QUINALDINE RESIDUE ...2.0237

THE EFFICACY OF MONSANTO NO. 51294 AS A FISH TOXICANT (LABORATORY) ...2.0243

STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES ...2.0256

POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIPMINE LAKES IN SOUTHEAST KANSAS ...4.0078

Quinaldine

STUDIES OF SHARK REPELLENTS AND OTHER ANTISHARK MEASURES ...2.0191

U.V. SPECTROPHOTOMETRY FOR THE IDENTIFICATION AND ESTIMATION OF QUINALDINE RESIDUE ...2.0237

THE EFFICACY OF QUINALDINE SULFATE - MS-222 AS AN ANESTHETIC FOR FISH IN THE LABORATORY - WARM SPRINGS ...2.0239

ROUTE(S) OF EXCRETION OF QUINALDINE SULFATE, A FISH ANESTHETIC ...2.0249

TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS ...3.0112

Rotenone

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034

TOXICITY OF POLLUTANTS TO STRIPED BASS ...1.0251

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260

STUDY ON THE EFFECTS OF FISH TOXICANTS ANTIMYCIN A AND ROTENONE ON POND COMMUNITIES ...1.0366

RESTORING 'BALANCE' WITH ROTENONE AND FINTROL ...2.0194

SURVIVAL AND GROWTH OF KOKANEE AND COHO SALMON IN ANDERSON RANCH RESERVIOR ...2.0197

ROTENOIDS FROM TEPHROSIA VOGELII ...2.0198

EXPERIMENTAL RESTORATION OF THE GILA TROUT ...2.0218

DEVELOPMENT OF ACCURATE CHEMICAL INTRODUCTION TECHNIQUES ...2.0223

TIME-CONCENTRATION TESTS INVOLVING NEUTRALIZATION OF ROTENONE WITH POTASSIUM PERMANGANATE ...2.0224

NEUTRALIZATION OF ROTENONE WITH ACTIVATED CHARCOAL ...2.0225

THE TOXICITY AND DETOXIFICATION OF THE ROTENONE FORMULATIONS USED IN FISH MANAGEMENT ...2.0226

AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO ...2.0227

PISCICIDE TOXICOLOGY OF THE CYPRINIDS IN EAST AND WEST PAULINA LAKES ...2.0228

TFM

RESIDUES OF TFM IN FISH--LA CROSSE ...1.0315

THE DEVELOPMENT OF ANALYTICAL METHODS CAPABLE OF MEASURING TFM RESIDUES IN FISH, WATER, AND OTHER COMPLEX SUBSTRATES ...2.0238

IN VIVO AND IN VITRO STUDIES ON THE MODE OF ACTION OF TFM ...2.0250

METABOLISM AND EXCRETION OF TFM ...2.0251

THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...2.0252

Plant Antibiotic

Terramycin

EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...3.0119

Repellents

Deet

ATTRACTIVENESS AND REPELLENCY OF MAN TO MOSQUITO BITES ...4.0041

Tributyltinacetate

METHOD OF KILLING ONCOMELANIA & AQUATIC SNAIL VECTORS OF SCHISTOSOMIASIS ...2.0285

Triazines -nonspecific

ANALYTICAL METHODS FOR PESTICIDES IN SOIL AND WATER ...1.0018

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0038

CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS ...1.0042

ANALYTICAL METHODS FOR PESTICIDES AND PESTICIDE DEGRADATION PRODUCTS ...1.0088

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0334

CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...2.0160

Uracils -nonspecific

CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...1.0004

Wood Preservatives

EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...2.0267

EFFECT OF PRETREATMENT MOLDING OF SOUTHERN PINE ON THE PERMANENCE OF THE PRESERVATIVE IN SEA-WATER EXPOSURE ...2.0295

Creosote

EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...2.0267

EFFECT OF PRETREATMENT MOLDING OF SOUTHERN PINE ON THE PERMANENCE OF THE PRESERVATIVE IN SEA-WATER EXPOSURE ...2.0295

MARINE PILING ANALYSIS ...2.0296

Petroleum

A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0140

A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0158

pH -water

PROPERTIES OF TILE DRAINAGE WATER ...1.0045

FATE OF PESTICIDES ...1.0064

SOILS, PESTICIDES, AND THE QUALITY OF WATER ...1.0103

AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117

UPPER ST. JOHNS RIVER BASIN WATER QUALITY, FLORIDA ...1.0134

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

ADSORPTION OF PESTICIDES FROM SEA WATER ...1.0159

QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...1.0236

STATIC BIOASSAY OF TRACERS AND DYES AGAINST FISH AND INVERTEBRATES ...1.0316

ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...1.0326

AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...1.0343

INFLUENCE OF PESTICIDES & OTHER HYDROCARBONS ON GROWTH OF EURYTOLERANT MICROALGAE ...2.0148

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174

PISCICIDE TOXICOLOGY OF THE CYPRINIDS IN EAST AND WEST PAULINA LAKES ...2.0228

EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT) ...2.0229

EVALUATE FISH TOXICANT (ANTIMYCIN) (EAGLE LAKE SEGMENT) ...2.0230

STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0255

STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES ...2.0256

STATIC BIOASSAY OF COLLECTING AIDS AGAINST FISH ...2.0257

STATIC BIOASSAY OF ATTRACTANTS AND REPELLANTS AGAINST FISH AND INVERTEBRATES ...2.0258

THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...2.0261

PATHOLOGY OF AEROMONAS LIQUIFACIENS IN CHANNEL CATFISH ...3.0013

OYSTER DISEASE MORTALITY ALONG THE CALIFORNIA COAST ...3.0022

ETIOLOGY OF ESTUARINE FISH DISEASES ...3.0040

USE OF CELL CULTURE METHODS TO ATTEMPT TO FOLLOW DEVELOPING STAGES OF SPORES ...3.0062

THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER ...4.0004

TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005

AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...4.0011

BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...4.0012

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024

WATER QUALITY REQUIREMENTS OF AQUATIC INSECTS ...4.0066

POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078

Phenols

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086

ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...1.0153

GROUND AND SURFACE WATERS - POLLUTION ...1.0182

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183

Pheromones

BIOLOGY AND CONTROL OF MOSQUITOES IN IRRIGATED AND WATER MANAGEMENT AREAS ...2.0011

EVALUATION OF NEW INSECTICIDES ...2.0015

SUPPRESSION AND ECOLOGY OF MOSQUITOES ...2.0018

INVESTIGATIONS OF PHEROMONES AS CHEMOSTERILANTS FOR INSECTS WITH SPECIAL REFERENCE TO SYNTHETIC QUEN SUBSTANCE AND ITS ANALOGUES ...2.0021

INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...2.0030

BIOLOGICAL EVALUATION OF INSECT CONTROL AGENTS ...2.0050

ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089

THE USE OF PHEROMONES BY CARP, CYPRINUS CARPIO-RESEARCH ...2.0217

CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266

GENETICS AND REPRODUCTIVE BIOLOGY OF AEDES MOSQUITOES ...4.0055

Phosphine

INSECT CHEMOSTERILANTS ...2.0049

Phosphorous

SOILS, PESTICIDES, AND THE QUALITY OF WATER ...1.0103

INSECT CHEMOSTERILANTS ...2.0049

Phosphate

FLUORESCENT PROBES IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS FOR WATER POLLUTION ...1.0137

ATOMIC ABSORPTION ANALYSIS OF PHOSPHATES IN WATER ...1.0227

Phosphorus

PROPERTIES OF TILE DRAINAGE WATER ...1.0045

SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...**1.0066**

NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...**1.0073**

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...**1.0161**

AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...**1.0186**

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...**1.0191**

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...**1.0192**

QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...**1.0204**

MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...**1.0292**

DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...**2.0094**

GROWTH REGULATORS AND MINERAL NUTRITION IN AQUATIC PLANT CONTROL ...**2.0134**

CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...**2.0185**

INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...**4.0001**

THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER ...**4.0004**

THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0014**

RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...**4.0019**

THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0020**

Phosphates

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...**1.0053**

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...**1.0155**

LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION ...**1.0178**

FERTILIZERS AND SEDIMENTS AS WATER POLLUTANTS ...**1.0179**

QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...**1.0187**

ATOMIC ABSORPTION ANALYSIS OF PHOSPHATES IN WATER ...**1.0227**

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0269**

NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...**2.0180**

MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...**3.0082**

A PROPOSAL TO STUDY PHOSPHATE INDUCED ALGAL GROWTH IN ORDER TO SUPPRESS OR ELIMINATE THIS PHENOMENA ...**4.0021**

EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...**4.0023**

ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...**4.0069**

POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...**4.0078**

Photography

Aerial Photography

QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...**1.0204**

Photolysis

SOILS, PESTICIDES, AND THE QUALITY OF WATER ...**1.0103**

PHOTOCHEMICAL METHODS FOR PURIFYING WATER ...**1.0115**

Photoperiod

MODE OF ACTION OF INSECTICIDES AS RELATED TO INSECT METABOLISM AND BEHAVIOR ...**1.0266**

DEVELOPMENT AND BEHAVIOR OF BITING DIPTERA ...**2.0023**

EMERGENCY INSECT CONTROL ...**2.0076**

MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...**3.0106**

ANATOMICAL, PHYSIOLOGICAL AND ECOLOGICAL STUDIES ON MYRIOPHYLLUM SPICATIU ...**4.0013**

THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0020**

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0024**

BIONOMICS OF SELECTED NORTH AMERICAN CULICINE MOSQUITOES ...**4.0054**

PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA ...**4.0074**

Long Day

THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0014**

Photosensitizer

PHOTOCHEMICAL METHODS FOR PURIFYING WATER ...**1.0115**

Phreatophytes

BIOLOGICAL CONTROL - TAMARISK AND OTHER PHREATOPHYTES ...**2.0164**

CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...**2.0187**

Physical Control

Bait Traps

ECOLOGICAL STUDIES OF WILDLIFE MANAGEMENT PRACTICES ...**1.0327**

BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...**2.0040**

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...**2.0079**

FEEDING HABITS OF MOSQUITO LARVAE ...**4.0034**

Barriers & Weirs

EXPERIMENTAL RESTORATION OF THE GILA TROUT ...**2.0218**

Burning or Flaming

CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...**1.0004**

THE USE OF FLAME FOR CONTROLLING WEEDS AND BRUSH ...**2.0136**

FOREST AND FARM GAME HABITAT; FISH POND ...**2.0143**

IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION ...**2.0182**

Colors

DEVELOPMENT AND BEHAVIOR OF BITING DIPTERA ...**2.0023**

INSECTS AFFECTING MAN AND ANIMALS ...**2.0081**

Electrical

INVESTIGATION OF HANDLING TECHNIQUES ...**3.0111**

Geometric Surface Patterns

INSECTS AFFECTING MAN AND ANIMALS ...**2.0081**

Habitat Manipulation

INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025
BIOLOGY AND WATER MANAGEMENT STUDIES FOR CONTROL OF LOUISIANA MOSQUITOES (RICE FIELDS) ...2.0044
BIOLOGICAL AND BIOCHEMICAL FACTORS INFLUENCING THE DEVELOPMENT OF LARVAL MOSQUITO POPULATIONS ...2.0052
MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...2.0060
MOSQUITO CONTROL - TIDAL MARSHES ...2.0063
WATER MANAGEMENT IN MOSQUITO IMPOUNDMENTS ...2.0064
MOSQUITO CONTROL IN UPLAND SWAMPS ...2.0065
CONTROLLING MOSQUITOES ON HAYING MEADOWS ...2.0066
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE 1 ...2.0073
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...2.0075
EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082
AQUATIC PLANT CONTROL ...2.0128
EVALUATION OF POND CONDITIONS FOLLOWING FERTILIZATION ...2.0153
CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...2.0154
WATERLEVEL MANAGEMENT ON IMPOUNDMENTS OF LOW QUALITY SOILS ...2.0163
EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168
EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...2.0171
NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180
BIOLOGICAL AND LIMNOLOGICAL INVENTORY OF SEVEN FLOOD CONTROL RESERVOIRS IN THE STATE OF INDIANA ...2.0199
ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024
EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029

Light Traps

BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...2.0006
INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025
INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...2.0030
BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS ...2.0033
BIOLOGY AND ECOLOGY OF SALT-MARSH MOSQUITOES OF LOUISIANA ...2.0042
BIOLOGY AND WATER MANAGEMENT STUDIES FOR CONTROL OF LOUISIANA MOSQUITOES (RICE FIELDS) ...2.0044
BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS ...2.0054
BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...2.0057
DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053
OCCURRENCE AND BIONOMICS OF BLOODSUCKING MIDGES (DIPTERA: CERATOPOGONIDAE) IN IOWA ...4.0056
MOSQUITOES AS VECTORS OF LIVESTOCK DISEASES ...4.0065
ENTOMOLOGY DEVELOPMENT OF A LIGHTWEIGHT TRAP FOR COLLECTION OF MOSQUITOES FOR VIRUS ISOLATION ...4.0071

Mechanical Control

AQUATIC WEED CONTROL RESEARCH ...2.0100
WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104
FOREST AND FARM GAME HABITAT; FISH POND ...2.0143
AQUATIC PLANT CONTROL - EQUIPMENT FOR MECHANICAL AND CHEMICAL DESTRUCTION ...2.0147
WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...2.0176
IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...2.0181
IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION ...2.0182
CHANGES IN WATER ENVIRONMENT RESULTING FROM AQUATIC PLANT CONTROL ...2.0183

Physcontrol -other

CONTROL OF AQUATIC WEEDS BY USE OF N2-CO2-HE LASER SYSTEMS ...2.0091
ALGAE CONTROL BY ARTIFICIAL MIXING IN LAKE COCHITUATE ...2.0149

Radiation

INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...2.0029
CONTROL OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA FILTRATION AND ULTRAVIOLET IRRADIATION ...3.0129

Steel Traps

EVALUATION OF WATERFOWL PREDATOR CONTROL METHODS ...2.0272

Traps -other

ECOLOGICAL STUDIES OF WILDLIFE MANAGEMENT PRACTICES ...1.0327
BIOLOGY AND CONTROL OF PASTURE MOSQUITOES ...2.0008
TESTING ADULT ATTRACTION DEVICES AND CHEMOSTERILANTS FOR TABANID FLY CONTROL ...2.0024
SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...2.0206

Ultrasonic

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...2.0096

Physical Water Properties

ESTUARINE ECOSYSTEMS ...1.0128
EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133
WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...1.0162
EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168
DEVELOPMENT OF RHODAMINE-B DYE TO TRACE FLOW AND DISPERSION PATTERNS IN STREAMS AS AN ADJUNCT TO TREATING STREAMS WITH FISH-CONTROL CHEMICALS ...2.0245
OCCURRENCE OF FILAMENTOUS SLIMES ORGANISMS BELOW OUTFALLS ...4.0009
POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078

Phytotoxicity

RESPROUTING OF CHAPARRAL ...1.0017
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081
PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...1.0090
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0097
CONTROL OF AQUATIC WEEDS ...2.0113

ALGACIDES FOR USE IN WATER RECLAMATION AND REUSE SYSTEMS ...**2.0177**

CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...**2.0178**

Piezometry

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...**2.0096**

Pigments, Plant -nonspecific

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...**2.0168**

Pilot Plants

PHOTOCHEMICAL METHODS FOR PURIFYING WATER ...**1.0115**

DEVELOPMENT OF TREATMENT PROCESS FOR CHLORINATED HYDROCARBON PESTICIDE MANUFACTURING AND PROCESSING WASTES ...**1.0118**

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...**1.0183**

DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...**1.0184**

EUTROPHICATION - PILOT OPERATIONS ...**2.0172**

Pipelines

INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...**2.0106**

AQUATIC PEST CONTROL ...**2.0112**

Plankton

Phytoplankton

GREEN BAY RESEARCH PROGRAM ...**1.0112**

LIMNOLOGICAL FACTORS AFFECTING PESTICIDE RESIDUES IN SURFACE WATERS ...**1.0149**

THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM ...**1.0350**

DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...**2.0094**

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...**2.0168**

EUTROPHICATION - EFFECT OF WEED HARVESTING ...**2.0169**

MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...**3.0082**

INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...**4.0001**

RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY ...**4.0002**

PHYTOPLANKTON NUTRITION AND PHOTOSYNTHESIS IN EUTROPHIC LAKES ...**4.0016**

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...**4.0018**

EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...**4.0023**

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0024**

NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE ...**4.0025**

EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...**4.0029**

Plankton -nonspecific

OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...**1.0219**

CHLORINATED ORGANIC CONTAMINANTS IN THE MILWAUKEE RIVER ...**1.0226**

THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...**1.0297**

ACCUMULATION OF PESTICIDES IN MENHADEN ...**1.0299**

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...**1.0334**

CHEMICAL CONTROL OF WEEDS IN PONDS ...**2.0093**

ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0117**

DETERMINATION OF THE EFFECTS OF A FERTILIZER-INDUCED PLANKTON TURBIDITY, SUPPLEMENTED BY HERBICIDES, ON SUBMERGED AQUATIC PLANTS ...**2.0137**

LIMNOLOGICAL, ICHTHYOLOGICAL, AND PARASITOLOGICAL INVESTIGATIONS ON ARKANSAS RESERVOIRS IN RELATION TO WATER QUALITY ...**3.0019**

ENVIRONMENTAL STUDY ...**3.0030**

LAKE SUPERIOR PERIPHYTON IN RELATION TO WATER QUALITY ...**4.0017**

POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...**4.0078**

Zooplankton

A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...**1.0140**

A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...**1.0158**

EFFECTS OF WATER POLLUTION ON ZOOPLANKTON ...**1.0207**

FARM FISH POND MANAGEMENT ...**1.0340**

EVALUATION OF POND CONDITIONS FOLLOWING FERTILIZATION ...**2.0153**

EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...**4.0029**

Plankton Sampling

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...**4.0018**

STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...**4.0022**

Planning

INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...**1.0224**

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...**3.0029**

INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...**4.0059**

LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN ...**4.0082**

Plant Characteristics

Aesthetic

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...**1.0161**

Age

LABORATORY STUDY OF AQUATIC ENVIRONMENTAL FACTORS AND PLANT GROWTH STAGES ON AQUATIC WEED GROWTH AND HERBICIDAL RESPONSE ...**2.0111**

Annual

DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...**1.0196**

WEED CONTROL IN RICE PRODUCTION ...**2.0097**

WEED CONTROL IN RICE PRODUCTION ...**2.0098**

WEED CONTROL IN CITRICULTURE ...**2.0123**

FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...**2.0142**

WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...2.0179

Density

WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...1.0005

Flowering

TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024

Germination

FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS ...2.0141

BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162

CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...2.0178

Growth Habit

STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...2.0159

Growth Rate

CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...1.0024

ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...1.0326

EFFECT OF COPPER SULFATE ON AQUATIC WEEDS ...2.0108

LABORATORY STUDY OF AQUATIC ENVIRONMENTAL FACTORS AND PLANT GROWTH STAGES ON AQUATIC WEED GROWTH AND HERBICIDAL RESPONSE ...2.0111

CONTROL OF AQUATIC WEEDS ...2.0113

THE USE OF FLAME FOR CONTROLLING WEEDS AND BRUSH ...2.0136

FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS ...2.0141

EXPANDED AQUATIC PLANT CONTROL PROJECT ...2.0146

INFLUENCE OF PESTICIDES & OTHER HYDROCARBONS ON GROWTH OF EURYTOLERANT MICROALGAE ...2.0148

THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...2.0150

BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162

BIOLOGICAL CONTROL - TAMARISK AND OTHER PHREATOPHYTES ...2.0164

FACTORS CONTROLLING THE GROWTH OF THE AQUATIC WEED SALVINIA ...2.0166

EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...2.0171

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174

NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180

CHANGES IN WATER ENVIRONMENT RESULTING FROM AQUATIC PLANT CONTROL ...2.0183

ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...4.0001

ANATOMICAL, PHYSIOLOGICAL AND ECOLOGICAL STUDIES ON MYRIOPHYLLUM SPICATIU ...4.0013

THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0014

LAKE SUPERIOR PERIPHYTON IN RELATION TO WATER QUALITY ...4.0017

RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...4.0019

A PROPOSAL TO STUDY PHOSPHATE INDUCED ALGAL GROWTH IN ORDER TO SUPPRESS OR ELIMINATE THIS PHENOMENA ..4.0021

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024

Height

RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...2.0161

Maturity & Growth Stages

HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...1.0107

INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...2.0144

WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...2.0176

Number

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024

Perennial

PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS ...1.0055

DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...1.0196

WEED CONTROL IN RICE PRODUCTION ...2.0097

WEED CONTROL IN RICE PRODUCTION ...2.0098

FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...2.0142

WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...2.0179

Processing

IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...2.0181

Quality -nonspecific

WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...2.0176

ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

Sex

REPRODUCTION & FUNGAL PARASITES AFFECTING REPRODUCTION IN LOBSTER, HUMARUS AMERICANNA, & BLUE CRAB CALLINECTES SAPIDUS, IN N.C. WATERS ...3.0115

Shape

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...2.0096

Species, Comparison of

RESPROUTING OF CHAPARRAL ...1.0017

RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...2.0161

Taste & Flavor

ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

Yield

PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...1.0090

WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...2.0176

WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...2.0179

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024

Plant Morphology Parameters

RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...1.0057

Buds

EXPANDED AQUATIC PLANT CONTROL PROJECT ...2.0146

Leaves

REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0046

Mycelia

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082

SELECTED PESTICIDES IN AQUATIC FUNGI IN THE THREE RIVERS AREA ...1.0345

Seeds

BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162

LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010

Sporangia

CULTIVATION OF COELOMOMYCES, A FUNGAL PARASITE OF MOSQUITOES ...2.0031

CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS ...2.0265

Spores

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082

Stems

Rhizomes

BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162

Sprout

RESPROUTING OF CHAPARRAL ...1.0017

Vascular

Phloen

CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS ...2.0265

Plant Pathology

Biological Control

BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...2.0121

Dutch Elm Disease

INSECTICIDES AND EGG-SHELL DEPOSITION ...1.0368

Fungi -nonspecific

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105

NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135

NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188

Host-parasite Interactions

BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...4.0012

Rots

Foot Rot

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105

Root Rot

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105

Soil-borne Diseases

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105

Survey

BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...2.0121

BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...4.0012

Virulence, Pathogenicity

BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...2.0122

NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188

THE NUTRITION AND BEHAVIOR OF MOSQUITOES ...4.0033

Water-borne Diseases

BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...2.0121

Plant Physiology

Absorption (incl. Adsorption)

GROWTH REGULATORS AND MINERAL NUTRITION IN AQUATIC PLANT CONTROL ...2.0134

Root Absorption

FATE OF PESTICIDES ...1.0064

Dormancy (excl. Respiration)

Seeds

FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS ...2.0141

Growth and Differentiation

AQUATIC PEST CONTROL ...2.0112

CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...2.0154

INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...4.0001

THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0014

RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...4.0019

THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0020

TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ...4.0030

Metabolism

Carbohydrates

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0118

Cell and Tissue Permeability

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...2.0096

EXPANDED AQUATIC PLANT CONTROL PROJECT ...2.0146

Herbicides and Chemicals

RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...1.0057

FATE OF INSECTICIDES IN SOIL AND THEIR MOVEMENT IN WATER AND CROPS ...1.0111

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0228

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319

TOXICOLOGY OF PESTICIDES IN THE ENVIRONMENT ...1.0360

EXPANDED AQUATIC PLANT CONTROL PROJECT ...2.0146

BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162

LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010

Mineral Nutrition

AQUATIC WEED CONTROL RESEARCH ...2.0100

AQUATIC PEST CONTROL ...2.0112

GROWTH REGULATORS AND MINERAL NUTRITION IN AQUATIC PLANT CONTROL ...2.0134

THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0014**

THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0020**

NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE ...**4.0025**

Nitrogen Metabolism

CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...**1.0025**

FACTORS CONTROLLING THE GROWTH OF THE AQUATIC WEED SALVINIA ...**2.0166**

Photoperiodism

ANATOMICAL, PHYSIOLOGICAL AND ECOLOGICAL STUDIES ON MYRIOPHYLLUM SPICATIU ...**4.0013**

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0024**

Photosynthesis

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...**2.0096**

THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...**2.0150**

NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE ...**4.0025**

Respiration

THE DISPOSITION OF PESTICIDES IN THE SOIL ...**1.0030**

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...**2.0096**

Translocation

CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...**1.0025**

FATE OF INSECTICIDES IN SOIL AND THEIR MOVEMENT IN WATER AND CROPS ...**1.0111**

EXPANDED AQUATIC PLANT CONTROL PROJECT ...**2.0146**

Transpiration and Evaporation

FATE OF PESTICIDES ...**1.0064**

Reproductive Physiology

GROWTH SUPPRESSION AND REDUCTION IN REGROWTH POTENTIAL OF AQUATIC WEEDS ...**2.0110**

ANATOMICAL, PHYSIOLOGICAL AND ECOLOGICAL STUDIES ON MYRIOPHYLLUM SPICATIU ...**4.0013**

AQUATIC PLANTS OF POLLUTED WATERS IN SOUTHWESTERN UNITED STATES ...**4.0028**

Plant Resistance to ....

Heat Resistance

THE USE OF FLAME FOR CONTROLLING WEEDS AND BRUSH ...**2.0136**

Planting Methods

WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...**2.0176**

Plants - Conifers

Juniperus

CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...**1.0004**

Pseudotsuga

BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...**1.0083**

CLASSIFICATION, BIONOMICS, ECOLOGY CONTROL OF FOREST INSECTS (OTHER THAN SCOLYTIDAE) IN CAL. ...**1.0321**

Plants - Dicots

WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...**1.0005**

DISPOSITION OF PESTICIDES IN THE SOIL ...**1.0031**

WEED CONTROL IN CITRICULTURE ...**2.0123**

Amaranthaceae

CONTROL OF AQUATIC WEEDS BY USE OF N2-CO2-HE LASER SYSTEMS ...**2.0091**

CHEMICAL CONTROL OF WEEDS IN PONDS ...**2.0093**

BIOLOGICAL CONTROL OF WEEDS ...**2.0099**

BIOLOGICAL CONTROL OF WEEDS ...**2.0102**

EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...**2.0116**

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0118**

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0129**

NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...**2.0135**

INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...**2.0144**

INSECTS ASSOCIATED WITH AQUATIC WEED PESTS OF FOREIGN ORIGIN ...**2.0145**

EXPANDED AQUATIC PLANT CONTROL PROJECT ...**2.0146**

METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...**2.0186**

INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...**4.0001**

Asclepiadaceae

COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...**1.0145**

Betulaceae

BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...**1.0083**

Campanulaceae

FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS ...**2.0141**

Ceratophyllaceae

EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...**2.0116**

NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...**2.0188**

TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ...**4.0030**

Chenopodiaceae

Salsola

BIOLOGICAL CONTROL OF WEEDS ...**2.0099**

Spinacia

NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...**1.0027**

Compositae

INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...**2.0280**

Ambrosia

CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...**1.0025**

BIOLOGICAL CONTROL OF WEEDS ...**2.0102**

Cirsium

BIOLOGICAL CONTROL OF WEEDS ...**2.0099**

CONTROL OF CANADA THISTLE AND WATER WEEDS ...**2.0158**

STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...2.0159
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...2.0160

Helianthus
EMERGENCY INSECT CONTROL ...2.0076

Lactuca
INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015

Senecio
BIOLOGICAL CONTROL OF WEEDS ...2.0099

Convolvulaceae

Ipomoea
CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025

Cruciferae
MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...2.0019

Brassica Species
ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

Cucurbitaceae
CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025

Cucumis Sativus
FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095

Cucurbita
CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025

Ericaceae

Vaccinium
PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS ...1.0055
TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...1.0056

Fagaceae

Quercus Dumosa
RESPROUTING OF CHAPARRAL ...1.0017

Quercus Gambellii
CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...1.0004

Quercus Virginiana
CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATFD WEEDS ...1.0004

Guttiferae
ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0117

Haloragaceae
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0228
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319
CHEMICAL CONTROL OF WEEDS IN PONDS ...2.0093
BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0118
INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...2.0144
CONTROL OF UNDESIRABLE AQUATIC VEGETATION ...2.0155
CONTROL OF EURASIAN MILFOIL ...2.0156
INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...2.0167
NATURAL ENEMIES OF EURASIAN WATERMILFOIL IN PAKISTAN ...2.0173
CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...2.0185
NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188
BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...4.0012
ANATOMICAL, PHYSIOLOGICAL AND ECOLOGICAL STUDIES ON MYRIOPHYLLUM SPICATIU ...4.0013
THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0014
THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0020
EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...4.0023
ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024

Labiatae
REDUCTION OF PESTICIDE RESIDUE HAZARDS ...1.0040
BIOLOGICAL CONTROL OF WEEDS ...2.0099

Leguminosae

Arachis
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0002
FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095

Glycine
EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010
INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015
CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0097

Medicago
BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053
PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES ...1.0062
ANALYTICAL METHODS FOR PESTICIDES AND PESTICIDE DEGRADATION PRODUCTS ...1.0088
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145

Pisum
ENTOMOLOGICAL PESTS OF VEGETABLE CROPS ...2.0288

Prosopis
EFFECT OF PESTICIDES ON THE QUALITY OF SURFACE AND GROUND WATERS IN THE WESTERN GULF REGION ...1.0101

Tephrosia
ROTENOIDS FROM TEPHROSIA VOGELII ...2.0198

Lythraceae
FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS ...2.0141

Malvaceae

Gossypium
EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0097
CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...1.0189

CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...**1.0235**
EVALUATION OF NEW INSECTICIDES ...**2.0015**

Nymphaeaceae
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0129**
BIOLOGY AND CONTROL OF AQUATIC WEEDS ...**2.0162**

Onagraceae
CONTROL OF AQUATIC WEEDS BY USE OF N2-CO2-HE LASER SYSTEMS ...**2.0091**
NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...**2.0135**

Polygonaceae
ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...**2.0001**
THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...**2.0130**
WATERLEVEL MANAGEMENT ON IMPOUNDMENTS OF LOW QUALITY SOILS ...**2.0163**

Rosaceae
Prunus Ceracus & P. Avium
REDUCTION OF PESTICIDE RESIDUE HAZARDS ...**1.0040**
Prunus Persica
REDUCTION OF PESTICIDE RESIDUE HAZARDS ...**1.0040**
Pyrus Communis
REDUCTION OF PESTICIDE RESIDUE HAZARDS ...**1.0040**

Rutaceae
Citrus
NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...**1.0027**
WEED CONTROL IN CITRICULTURE ...**2.0123**

Salicaceae
Salix
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...**2.0178**

Saxifragaceae
EMERGENCY INSECT CONTROL ...**2.0076**

Scrophulariaceae
EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS ...**1.0341**
NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...**2.0135**
FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS ...**2.0141**

Solanaceae
Capsicum
CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...**1.0025**
Datura
CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...**1.0025**
BIOLOGICAL CONTROL OF WEEDS ...**2.0102**
Lycopersicum
INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...**1.0015**
CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...**1.0025**
Solanum Tuberosum
INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...**1.0015**
CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...**1.0025**

Tamaricaceae
BIOLOGICAL CONTROL - TAMARISK AND OTHER PHREATOPHYTES ...**2.0164**
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...**2.0178**
CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...**2.0187**

Umbelliforae
Daucus
INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...**1.0015**
NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...**1.0027**

Plants - Ferns

Filicales
FACTORS CONTROLLING THE GROWTH OF THE AQUATIC WEED SALVINIA ...**2.0166**

Hydropteridales
MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...**2.0124**

Plants - Monocots

Araceae
CONTROL OF AQUATIC WEEDS BY USE OF N2-CO2-HE LASER SYSTEMS ...**2.0091**
EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...**2.0116**
BIOLOGY AND CONTROL OF AQUATIC WEEDS ...**2.0162**
METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...**2.0186**

Commelinaceae
WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...**2.0176**

Cyperaceae
CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...**1.0025**
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...**1.0145**
CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...**2.0101**
NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...**2.0135**
CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA .. **2.0187**

Gramineae
Andropogoneae -other
LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...**4.0010**
Avena Sativa
WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...**1.0005**
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...**1.0145**
DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...**1.0196**
EMERGENCY INSECT CONTROL ...**2.0076**
CONTROL OF AQUATIC WEEDS ...**2.0113**

Aveneae -other

LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...**4.0010**

Bromus

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...**1.0053**

Chlorideae -other

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...**3.0029**

Digitaria

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0009**

Festuca

COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...**1.0145**

Festuceae -other

BIOLOGY AND CONTROL OF AQUATIC WEEDS ...**2.0162**

Grass -nonspecific

EFFECT OF PESTICIDES ON THE QUALITY OF SURFACE AND GROUND WATERS IN THE WESTERN GULF REGION ...**1.0101**

QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...**1.0204**

CONTROLLING MOSQUITOES ON HAYING MEADOWS ...**2.0066**

RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...**2.0161**

Hordeum -other

CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...**2.0178**

Hordeum Vulgare

EMERGENCY INSECT CONTROL ...**2.0076**

Oryzeae

INVESTIGATION OF RICE IRRIGATION RETURN FLOWS - TEXAS COASTAL PRAIRIE REGION ...**1.0209**

ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...**2.0001**

EFFECT OF MOSQUITO CONTROL CHEMICALS ON AQUATIC FAUNA ...**2.0003**

MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...**2.0019**

WEED CONTROL IN RICE PRODUCTION ...**2.0097**

WEED CONTROL IN RICE PRODUCTION ...**2.0098**

USE OF CHEMICALS ON RICE ...**2.0140**

WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...**2.0176**

Other Agrostideae

COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...**1.0145**

Pennisetum

CHEMICAL CONTROL OF DITCHBANK WEEDS IN PEAT AND SANDY SOIL AREAS OF SOUTH FLORIDA ...**2.0114**

Phalarideae

CONTROL OF CANADA THISTLE AND WATER WEEDS ...**2.0158**

STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...**2.0159**

CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...**2.0178**

Poa Pratensis

CONTROL OF CANADA THISTLE AND WATER WEEDS ...**2.0158**

Saccharum

ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS ...**1.0049**

CHEMICAL CONTROL OF DITCHBANK WEEDS IN PEAT AND SANDY SOIL AREAS OF SOUTH FLORIDA ...**2.0114**

Secale

EMERGENCY INSECT CONTROL ...**2.0076**

Sorghum

INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...**1.0015**

Triticum

EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...**1.0074**

COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...**1.0145**

EMERGENCY INSECT CONTROL ...**2.0076**

Zea Mays - Field Corn

REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0046**

CONTROL OF PESTICIDES IN SOIL AND WATER ...**1.0054**

SOILS, PESTICIDES AND THE QUALITY OF WATER ...**1.0061**

EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...**1.0074**

FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...**1.0089**

PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...**1.0090**

FATE OF HERBICIDES IN PLANTS AND SOILS ...**1.0095**

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...**1.0191**

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...**1.0192**

RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION ...**1.0194**

THE USE OF FLAME FOR CONTROLLING WEEDS AND BRUSH ...**2.0136**

DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...**4.0053**

Zea Mays - Sweet Corn

CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...**1.0025**

Hydrocharitaceae

SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...**2.0095**

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...**2.0096**

BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0115**

EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...**2.0116**

ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0117**

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0118**

PROCESSING, CHEMICAL COMPOSITION, AND NUTRITIVE VALUE OF AQUATIC WEEDS ...**2.0119**

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0129**

GROWTH REGULATORS AND MINERAL NUTRITION IN AQUATIC PLANT CONTROL ...**2.0134**

INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...**2.0167**

INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...**4.0001**

TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...**4.0005**

THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0014**

THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0020**

EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...**4.0023**

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0024**

TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ... 4.0030

Juncaceae

EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE I ...2.0073
EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...2.0075

Lemnaceae

ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001
THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...2.0130
WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...2.0176

Liliaceae

Allium

INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...1.0015

Asparagus

CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025

Najadaceae

GROWTH SUPPRESSION AND REDUCTION IN REGROWTH POTENTIAL OF AQUATIC WEEDS ...2.0110
EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...2.0116
ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0117
METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186
INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...4.0001
ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024

Pontederiaceae

CONTROL OF AQUATIC WEEDS BY USE OF N2-CO2-HE LASER SYSTEMS ...2.0091
SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...2.0095
BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115
EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...2.0116
THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0118
PROCESSING, CHEMICAL COMPOSITION, AND NUTRITIVE VALUE OF AQUATIC WEEDS ...2.0119
SOUTHEASTERN BIOLOGICAL CONTROL OF WEEDS INVESTIGATIONS ...2.0120
NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135
FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS ...2.0141
INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...2.0144
INSECTS ASSOCIATED WITH AQUATIC WEED PESTS OF FOREIGN ORIGIN ...2.0145
CONTROL OF CANADA THISTLE AND WATER WEEDS ...2.0158
METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186
INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...4.0001
TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005
LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010

Potamogetonaceae

PESTICIDE RESIDUES ON ARIZONA CROPS ...1.0007
CONTROL OF AQUATIC WEEDS BY USE OF N2-CO2-HE LASER SYSTEMS ...2.0091
EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...2.0096
GROWTH SUPPRESSION AND REDUCTION IN REGROWTH POTENTIAL OF AQUATIC WEEDS ...2.0110
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...2.0178
INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...4.0001
THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0014
THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0020
EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...4.0023
ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024
THE CHANGING DISTRIBUTION OF THE GENUS POTAMOGETON (PONDWEEDS) IN OHIO ...4.0026

Typhaceae

UPTAKE AND RELEASE OF DALAPON IN EARTHEN PONDS ...1.0114
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...2.0178
CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187

Plants -nonspecific

ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106
RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS ...1.0138
AQUATIC PLANT CONTROL ...2.0128

Plastics

DEVELOPMENT OF FIELD METHODS IN SAMPLING WATER FOR PESTICIDE ANALYSIS ...1.0173

Polyethylene

DEVELOPMENT OF FIELD METHODS IN SAMPLING WATER FOR PESTICIDE ANALYSIS ...1.0173
PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105

Polyvinyl Chloride

PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105

Polyvinyls -other

INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106

Urethanes

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086

Platyhelminthes

Cestoda

MOLLUSCAN MORTALITY STUDIES ...3.0032

Platyhelminthes -other

IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...3.0018

Trematoda

Digenea

CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266

BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...2.0269

SCHISTOSOME CONTROL BY TREMATODE ANTAGONISM ...2.0270

THE BIOLOGY AND CONTROL OF THE SNAIL INTERMEDIATE HOST OF SCHISTOSOMES ...2.0276

BIOLOGY AND BIOLOGICAL CONTROL OF SCHISTOSOMIASIS ...2.0277

SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...2.0278

SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...2.0279

INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...2.0280

'A METHOD OF DESTROYING ONCOMELANIA-THE SNAIL VECTOR OF SCHISTOSOMIASIS' ...2.0284

CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER ...2.0290

MOLLUSCAN MORTALITY STUDIES ...3.0032

EXPERIMENTAL CONTROL OF NEASCUS IN SMALL TROUT LAKES ...3.0036

Trematoda -other

SCHISTOSOME CONTROL BY TREMATODE ANTAGONISM ...2.0270

SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...2.0278

MOLLUSCAN MORTALITY STUDIES ...3.0032

REFINEMENT OF MANAGEMENT TECHNIQUES FOR STREAM TROUT LAKES ...3.0035

EPIDEMOLOGY OF 'SALMON POISONING' DISEASE ...3.0054

ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044

Turbellaria

Planaria

CONTROL OF BLACK FLIES AND MOSQUITOES IN MAINE ...2.0046

Turbellaria -other

CONTROL OF BLACK FLIES AND MOSQUITOES IN MAINE ...2.0046

NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...2.0271

Playas

FATE OF POLLUTANTS IN GROUND WATER ...1.0079

EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...1.0100

Pollutant Identification

FLUORESCENT PROBES IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS FOR WATER POLLUTION ...1.0137

RAPID DETECTION OF TOXIC MATERIALS IN WATER ...1.0180

TRANSFER OF PESTICIDES THROUGH SOILS, WATER, SEDIMENTS AND AQUATIC LIFE ...1.0202

Bioindicators

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039

ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...1.0153

PESTICIDE MONITORING PROGRAM ...1.0156

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161

PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166

PRESTICIDE INPUTS AND LEVELS IN MINNESOTA WATERS OF THE LAKE SUPERIOR BASIN ...1.0167

MAYFLY DISTRIBUTION AS A WATER QUALITY INDEX ...1.0169

THE BIOASSAY OF WATER POLLUTANTS WITH CULTURED MAMMALIAN CELLS ...1.0200

PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN ...1.0213

ARTIFICIAL SUBSTRATE SAMPLERS AS INDICATORS OF WATER QUALITY ...1.0225

PESTICIDE MONITORING PROGRAM ...1.0238

A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0265

THE UPTAKE OF DIELDRIN IN THE THREE RIDGED NAIAD, AMBLEMA PLICATA ...1.0301

EFFECTS OF TOXICANTS UPON FISH MOVEMENT PATTERNS ...1.0308

SURVEY OF POND WEEDS AND PLANT SUCCESSION ...2.0127

CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER ...2.0290

EPIDERMAL PAPILLOMAS ...3.0021

EUTROPHICATION OF IOWA LAKES AND STREAMS ...4.0008

LAKE SUPERIOR PERIPHYTON IN RELATION TO WATER QUALITY ...4.0017

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...4.0018

Chemical Identification

FATE OF HARMFUL METALS IN SOIL AND WATER SYSTEMS ...1.0003

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0006

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013

ANALYTICAL METHODS FOR PESTICIDES IN SOIL AND WATER ...1.0018

ORGANIC SUBSTANCES IN WATER ...1.0119

FLUORESCENT PROBES IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS FOR WATER POLLUTION ...1.0137

STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES ...1.0142

SERVICES FOR THE QUANTITATIVE ANALYSIS OF PESTICIDES IN SEAWATER AND BIOLOGICAL SAMPLES ...1.0172

LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION ...1.0178

MAGNITUDE AND NATURE OF POLYCHLORINATED BIPHENYLS IN COHO SALMON ...1.0262

DEVELOPMENT OF TECHNIQUES FOR IDENTIFICATION OF PESTICIDES AND THEIR METABOLITES BY MASS SPECTROMETRY ...1.0295

THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...1.0297

SUBLETHAL AMOUNTS OF ORGANIC INSECTICIDES AND FISH ...1.0313

CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...2.0154

Physical Parameters

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0006

DETECTION AND IDENTIFICATION OF MOLECULAR WATER POLLUTANTS BY LASER RAMAN SPECTROSCOPY ...1.0151

CONCENTRATION AND ANALYSIS OF PESTICIDES AND OTHER RECALCITRANT MOLECULES IN WATER SUPPLIES BY ULTRAFILTRATION ...1.0185

Pollutants -general

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...1.0052

IDENTIFICATION AND DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND RUNOFF AND DRAINAGE WATERS. ...1.0110

MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...1.0160
PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0164
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0168
ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211
SOURCES OF QUALITY IMPAIRMENT OF SURFACE WATERS ...1.0218
EVALUATION OF PESTICIDE SOURCES AND LEVELS TRIBUTARY TO LAKES MICHIGAN AND SUPERIOR ...1.0221
ARTIFICIAL SUBSTRATE SAMPLERS AS INDICATORS OF WATER QUALITY ...1.0225

Pollutants - Path of

FATE OF HARMFUL METALS IN SOIL AND WATER SYSTEMS ...1.0003
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0006
MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS ...1.0011
SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL ...1.0012
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013
RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019
REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...1.0021
BEHAVIOR OF POLLUTANTS IN WATER ...1.0022
CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...1.0024
NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0027
NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029
PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...1.0032
PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...1.0033
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034
POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...1.0036
PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039
EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041
MOVEMENT OF HERBICIDES IN SOIL BY MASS FLOW ...1.0044
REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0046
ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS ...1.0049
WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...1.0050
PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...1.0052
BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053
CONTROL OF PESTICIDES IN SOIL AND WATER ...1.0054
PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS ...1.0055
TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...1.0056
RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...1.0057
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065
SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...1.0066
AN EVALUATION OF THE INSECTICIDE 'SEVIN' AS A WATERSHED POLLUTANT ...1.0067
ENVIRONMENTAL BIOLOGY - BIOGEOCHEMICAL CYCLING IN ECOLOGICAL SYSTEMS ...1.0068
MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...1.0071
PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...1.0075
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076
FATE OF POLLUTANTS IN GROUND WATER ...1.0079
EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS ...1.0080
BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0084
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0085
FATES OF AGRICULTURAL CHEMICALS IN SOILS ...1.0092
MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...1.0098
MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099
EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...1.0100
SOILS, PESTICIDES, AND THE QUALITY OF WATER ...1.0103
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105
ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106
FATE OF INSECTICIDES IN SOIL AND THEIR MOVEMENT IN WATER AND CROPS ...1.0111
METABOLISM OF ENDRIN IN PONDS ...1.0113
PREDICTING MINERAL QUALITY OF RETURN FLOW WATER ...1.0122
IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD ...1.0123
COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...1.0125
PESTICIDE KINETICS ...1.0127
ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN ...1.0132
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0141
THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0144
RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146
WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...1.0162
CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...1.0189
PESTICIDES MOVEMENT FROM CROPLAND INTO LAKE ERIE ...1.0193
RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION ...1.0194
TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE ...1.0201
TRANSFER OF PESTICIDES THROUGH SOILS, WATER, SEDIMENTS AND AQUATIC LIFE ...1.0202
DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215
OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...1.0219
PESTICIDE CONTAMINATION OF ENVIRONMENT ...1.0250
THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...1.0297
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0305
DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...1.0333
IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS ...1.0335

ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...1.0339

PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...1.0358

CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101

THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...2.0150

DEVELOPMENT OF RHODAMINE-B DYE TO TRACE FLOW AND DISPERSION PATTERNS IN STREAMS AS AN ADJUNCT TO TREATING STREAMS WITH FISH-CONTROL CHEMICALS ...2.0245

EUTROPHICATION OF IOWA LAKES AND STREAMS ...4.0008

NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE ...4.0025

INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...4.0027

Pollution -nonspecific

ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN ...1.0132

DESIGNING A GLOBAL ENVIRONMENTAL MONITORING SYSTEM ...1.0206

Pollution Abatement

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...1.0032

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...1.0052

QUALITY OF IRRIGATION RETURN FLOW ...1.0102

Pollution Effects On...

Biology

EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041

GREEN BAY RESEARCH PROGRAM ...1.0112

LAKE SUPERIOR PERIPHYTON IN RELATION TO WATER QUALITY ...4.0017

Ecological Effects

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0037

MULTI-DISCIPLINARY RESEARCH IN POLLUTION ...1.0070

BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083

INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0116

ESTUARINE ECOSYSTEMS ...1.0128

RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146

PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN ...1.0213

MICROBIOLOGY OF FARM PONDS ...1.0220

PESTICIDES RESEARCH ...1.0232

EFFECTS OF PARATHION AND MALATHION ON WARM-WATER FISH PONDS ...1.0283

THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...1.0297

DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...1.0333

ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...1.0339

BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342

POND ECOLOGY AND PRODUCTION AS AFFECTED BY SIMAZINE ...1.0353

PHARMACOLOGICAL AND ECOLOGICAL EFFECTS OF PESTICIDES ...1.0362

CHEMICAL BIOCIDES IN LAKES ...1.0364

THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...1.0365

INSECTICIDES AND EGG-SHELL DEPOSITION ...1.0368

INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...2.0167

INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...4.0001

RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY ...4.0002

EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...4.0023

INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...4.0027

ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...4.0069

Physiological Effects

EFFECTIVENESS OF IODINE FOR DISINFECTION OF PUBLIC WATER SUPPLIES & TO DETERMINE PHYSIOLOGICAL EFFECTS ON A HUMAN POPULATION ...1.0126

CENTER FOR STUDY OF THE HUMAN ENVIRONMENT ...1.0190

EFFECTS OF WATER POLLUTION ON ZOOPLANKTON ...1.0207

EFFECT OF ENDRIN ON EGG-SPERM FORMATION AND EMBRYONIC DEVELOPMENT ...1.0229

PRELIMINARY STUDIES ON ENDRIN AND OTHER PESTICIDE UPTAKES BY FINGERLING CHANNEL CATFISH ...1.0231

BEHAVIOR OF ESTUARINE ANIMALS ...1.0240

TOXICITY OF POLLUTANTS TO STRIPED BASS ...1.0251

THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...1.0253

PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES ...1.0254

LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES ...1.0258

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260

BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH ...1.0261

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269

EFFECTS ON THE SPERMIATION RESPONSE OF GOLDFISH AFTER EXPOSURE TO SELECTED PESTICIDES ...1.0270

NERVE IMPULSE TRANSMISSION CHARACTERISTICS OF ISOLATED FISH-NERVE PREPARATIONS PERFUSED WITH PHYSIOLOGICAL LEVELS OF SELECTED PESTICIDES ...1.0271

THE INFLUENCES OF ENVIRONMENTAL CONDITIONS ON THE TOXICITY OF PESTICIDES ...1.0278

CHRONIC EFFECTS OF DURSBAN ON WARM-WATER FISH ...1.0282

UPTAKE, PERSISTENCE AND METABOLITES OF SEVIN BY CHANNEL CATFISH ...1.0284

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0288

CONTINUOUS-FLOW BIOASSAY OF PESTICIDES TO EVALUATE THE ACUTE AND CHRONIC EFFECTS OF PESTICIDES TO FRESHWATER INVERTEBRATES ...1.0294

ACCUMULATION OF PESTICIDES IN MENHADEN ...1.0299

THE EFFECT OF DIELDRIN ON SURVIVAL AND DEVELOPMENT OF FISH EGGS ...1.0300

TOXICITY OF SELECTED METALS TO CONDITIONED FISH ...1.0302

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0304

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0305

EFFECTS OF TOXICANTS UPON FISH MOVEMENT PATTERNS ...1.0308

EFFECT OF PESTICIDE RESIDUES ON GAME FISH POPULATIONS ...1.0310
SUBLETHAL AMOUNTS OF ORGANIC INSECTICIDES AND FISH ...1.0313
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319
STUDY OF CHRONIC TOXICITY OF LINDANE TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0337
BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342
INFECTIOUS DISEASES OF SALMONID FISHES ...3.0049
EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...3.0083
CORRELATE NITROGEN GAS CONTENT OF WATER SUPPLIES WITH DISEASE ...3.0088

Environment

ECONOMIC EFFECTS OF PESTICIDES AND OTHER WASTES ON NATURAL RESOURCE QUALITY ...1.0026
GREEN BAY RESEARCH PROGRAM ...1.0112

Chemical Effects

FATE OF HARMFUL METALS IN SOIL AND WATER SYSTEMS ...1.0003
PHYSICAL AND CHEMICAL FACTORS AFFECTING FISH ...1.0246

Physical Effects

THE EFFECTS OF HERBICIDES, PESTICIDES, AND FERTILIZERS ON THE OPTICAL PROPERTIES OF WATER ...1.0177
PHYSICAL AND CHEMICAL FACTORS AFFECTING FISH ...1.0246
EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...3.0089
AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...3.0126

Pollution Effects -general

PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...1.0199
UPTAKE, PERSISTENCE AND METABOLITES OF SEVIN BY CHANNEL CATFISH ...1.0284
PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...1.0358
ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...4.0007
AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...4.0011

Pollution Effects -other

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039

Pollution Sources -water

FATE OF HARMFUL METALS IN SOIL AND WATER SYSTEMS ...1.0003
UPPER ST. JOHNS RIVER BASIN WATER QUALITY, FLORIDA ...1.0134
ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...1.0153
WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...1.0162
QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187
THE BIOASSAY OF WATER POLLUTANTS WITH CULTURED MAMMALIAN CELLS ...1.0200
THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...1.0297
TRIBUTARY SURVEY OF LAKES ONTARIO AND ERIE ...2.0220

Agricultural Chemicals

EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...1.0100
RURAL RUNOFF CONTROL ...1.0135

Fertilizers

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008
NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0027
NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029
PROPERTIES OF TILE DRAINAGE WATER ...1.0045
ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS ...1.0049
SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072
NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073
EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS ...1.0080
FATES OF AGRICULTURAL CHEMICALS IN SOILS ...1.0092
EVALUATION AND DEMONSTRATION OF IRRIGATION METHODS AND PRACTICES TO REDUCE CONTAMINATION IN IRRIGATION WASTE WATER ...1.0104
PREDICTING MINERAL QUALITY OF RETURN FLOW WATER ...1.0122
POLLUTION LOADS IN RUNOFF FROM SMALL AGRICULTURAL WATERSHEDS ...1.0154
THE EFFECTS OF HERBICIDES, PESTICIDES, AND FERTILIZERS ON THE OPTICAL PROPERTIES OF WATER ...1.0177
LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION ...1.0178
FERTILIZERS AND SEDIMENTS AS WATER POLLUTANTS ...1.0179
AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...1.0186
QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204
INVESTIGATION OF RICE IRRIGATION RETURN FLOWS - TEXAS COASTAL PRAIRIE REGION ...1.0209
RELATIVE LEACHING RATES OF COMMON NITROGEN CARRIERS FROM SANDY SOILS IN RELATION TO LAKE EUTROPHICATION ...4.0006

Pesticides

CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...1.0004
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0006
PESTICIDE RESIDUES ON ARIZONA CROPS ...1.0007
INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008
MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS ...1.0011
SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL ...1.0012
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013
VOLATILIZATION LOSSES OF PESTICIDES FROM SOILS ...1.0016
RESPROUTING OF CHAPARRAL ...1.0017
ANALYTICAL METHODS FOR PESTICIDES IN SOIL AND WATER ...1.0018
RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019
REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...1.0021
BEHAVIOR OF POLLUTANTS IN WATER ...1.0022
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023
CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...1.0024
CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025

ECONOMIC EFFECTS OF PESTICIDES AND OTHER WASTES ON NATURAL RESOURCE QUALITY ...1.0026

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029

THE DISPOSITION OF PESTICIDES IN THE SOIL ...1.0030

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...1.0032

PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...1.0033

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034

POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...1.0036

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0037

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039

EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041

CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS ...1.0042

PROPERTIES OF TILE DRAINAGE WATER ...1.0045

REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0046

REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...1.0047

ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS ...1.0049

WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...1.0050

CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...1.0051

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...1.0052

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053

CONTROL OF PESTICIDES IN SOIL AND WATER ...1.0054

PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS ...1.0055

TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...1.0056

ANALYSIS OF PESTICIDE RESIDUES ...1.0058

FATE OF PESTICIDES ...1.0064

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065

SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...1.0066

AN EVALUATION OF THE INSECTICIDE 'SEVIN' AS A WATERSHED POLLUTANT ...1.0067

ENVIRONMENTAL BIOLOGY - BIOGEOCHEMICAL CYCLING IN ECOLOGICAL SYSTEMS ...1.0068

MULTI-DISCIPLINARY RESEARCH IN POLLUTION ...1.0070

MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...1.0071

EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...1.0074

FATE OF POLLUTANTS IN GROUND WATER ...1.0079

EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS ...1.0080

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0085

PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...1.0090

CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0093

FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0097

MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...1.0098

MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099

EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...1.0100

EFFECT OF PESTICIDES ON THE QUALITY OF SURFACE AND GROUND WATERS IN THE WESTERN GULF REGION ...1.0101

QUALITY OF IRRIGATION RETURN FLOW ...1.0102

SOILS, PESTICIDES, AND THE QUALITY OF WATER ...1.0103

DEVELOPMENT OF ON-SITE BIOASSAY METHODS ...1.0108

INTERFERING SOIL CONSTITUENTS IN DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND WATER ...1.0109

IDENTIFICATION AND DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND RUNOFF AND DRAINAGE WATERS. ...1.0110

FATE OF INSECTICIDES IN SOIL AND THEIR MOVEMENT IN WATER AND CROPS ...1.0111

GREEN BAY RESEARCH PROGRAM ...1.0112

METABOLISM OF ENDRIN IN PONDS ...1.0113

PHOTOCHEMICAL METHODS FOR PURIFYING WATER ...1.0115

AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117

ORGANIC SUBSTANCES IN WATER ...1.0119

ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120

STUDY OF ELECTROHYDRAULIC WATER TREATMENT ...1.0121

PREDICTING MINERAL QUALITY OF RETURN FLOW WATER ...1.0122

IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD ...1.0123

ATTENTION AND RUNOFF OF PESTICIDES FROM AGRICULTURAL LANDS TO SURFACE WATERS ...1.0124

COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...1.0125

PESTICIDE KINETICS ...1.0127

ESTUARINE ECOSYSTEMS ...1.0128

CHEMICAL ANALYSES ...1.0129

EFFLUENT INFLUENCES OF THE MISSISSIPPI RIVER ON THE CHEMISTRY AND BIOLOGY OF ADJACENT OCEAN SYSTEMS ...1.0130

ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT ...1.0131

ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN ...1.0132

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133

UPPER ST. JOHNS RIVER BASIN WATER QUALITY, FLORIDA ...1.0134

FLUORESCENT PROBES IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS FOR WATER POLLUTION ...1.0137

RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS ...1.0138

TOXAPHENE CONTAMINATION - ESTUARINE ECOLOGY ...1.0139

A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0140

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0141

STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES ...1.0142

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...1.0143

RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146

GREAT LAKES PESTICIDE MONITORING PROGRAM, INDIANA ...1.0147

THE FACTOR CONTROLLING THE DYNAMICS OF NON-IONIC SYNTHETIC ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS ...1.0148

LIMNOLOGICAL FACTORS AFFECTING PESTICIDE RESIDUES IN SURFACE WATERS ...1.0149

DETECTION AND IDENTIFICATION OF MOLECULAR WATER POLLUTANTS BY LASER RAMAN SPECTROSCOPY ...1.0151

GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152

ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...1.0153

POLLUTION LOADS IN RUNOFF FROM SMALL AGRICULTURAL WATERSHEDS ...1.0154
PESTICIDE MONITORING PROGRAM ...1.0156
MASSACHUSETTS PESTICIDE MONITORING STUDY ...1.0157
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0158
ADSORPTION OF PESTICIDES FROM SEA WATER ...1.0159
MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...1.0160
AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161
PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0163
PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0164
PESTICIDE TESTING FOR SETTING STANDARDS ...1.0165
PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166
PRESTICIDE INPUTS AND LEVELS IN MINNESOTA WATERS OF THE LAKE SUPERIOR BASIN ...1.0167
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0168
PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...1.0170
DEVELOP IN-HOUSE CAPABILITY IN WATER QUALITY TECHNIQUES FOR ANALYSES OF HEAVY METALS, BACTERIA, AND PESTICIDE RESIDUES ...1.0171
SERVICES FOR THE QUANTITATIVE ANALYSIS OF PESTICIDES IN SEAWATER AND BIOLOGICAL SAMPLES ...1.0172
DEVELOPMENT OF FIELD METHODS IN SAMPLING WATER FOR PESTICIDE ANALYSIS ...1.0173
THE EFFECTS OF HERBICIDES, PESTICIDES, AND FERTILIZERS ON THE OPTICAL PROPERTIES OF WATER ...1.0177
LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION ...1.0178
FERTILIZERS AND SEDIMENTS AS WATER POLLUTANTS ...1.0179
RAPID DETECTION OF TOXIC MATERIALS IN WATER ...1.0180
SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...1.0181
GROUND AND SURFACE WATERS - POLLUTION ...1.0182
DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183
DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...1.0184
CONCENTRATION AND ANALYSIS OF PESTICIDES AND OTHER RECALCITRANT MOLECULES IN WATER SUPPLIES BY ULTRAFILTRATION ...1.0185
AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...1.0186
QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187
CHROMATOGRAPHIC CONCENTRATION OF PESTICIDES FROM A LARGE MASS OF WATER ...1.0188
CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...1.0189
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191
PESTICIDES MOVEMENT FROM CROPLAND INTO LAKE ERIE ...1.0193
RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION ...1.0194
QUANTITATIVE METHODS FOR PESTICIDES IN NATURAL WATERS ...1.0198
THE BIOASSAY OF WATER POLLUTANTS WITH CULTURED MAMMALIAN CELLS ...1.0200
TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE ...1.0201
TRANSFER OF PESTICIDES THROUGH SOILS, WATER, SEDIMENTS AND AQUATIC LIFE ...1.0202
FISHERIES UNIT ...1.0203
QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204
CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...1.0205
PESTICIDE LEVELS IN WATER AND WILDLIFE OF REELFOOT LAKE, TENNESSEE ...1.0208
INVESTIGATION OF RICE IRRIGATION RETURN FLOWS - TEXAS COASTAL PRAIRIE REGION ...1.0209
CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0210
ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211
LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...1.0212
PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN ...1.0213
DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215
IMPROVING WATER QUALITY BY REMOVAL OF PESTICIDE POLLUTANTS WITH AQUATIC PLANTS ...1.0216
PESTICIDE MONITORING ...1.0217
SOURCES OF QUALITY IMPAIRMENT OF SURFACE WATERS ...1.0218
OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...1.0219
MICROBIOLOGY OF FARM PONDS ...1.0220
EVALUATION OF PESTICIDE SOURCES AND LEVELS TRIBUTARY TO LAKES MICHIGAN AND SUPERIOR ...1.0221
TERMINAL RESIDUES OF CHLORINATED HYDROCARBON PESTICIDES IN LAKE MICHIGAN AND ASSOCIATED TRIBUTARIES ...1.0222
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0223
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0224
ARTIFICIAL SUBSTRATE SAMPLERS AS INDICATORS OF WATER QUALITY ...1.0225
ATOMIC ABSORPTION ANALYSIS OF PHOSPHATES IN WATER ...1.0227
PESTICIDES RESEARCH ...1.0232
THE OCCURRENCE OF PESTICIDE RESIDUES IN THE LOWER BRISBANE RIVER AND IN THE TISSUES OF ESTUARINE ANIMALS ...1.0233
RESEARCH STUDY ON THE EFFECTS OF POLLUTION ON SUB-TROPICAL FISH AND CRUSTACEANS ...1.0237
PESTICIDE MONITORING PROGRAM ...1.0238
ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...1.0239
BEHAVIOR OF ESTUARINE ANIMALS ...1.0240
LABORATORY BIOASSAYS ...1.0241
PHYSIOLOGY OF ESTUARINE ORGANISMS ...1.0242
EFFECTS OF PESTICIDES ON MARINE ANIMALS ...1.0244
PHYSICAL AND CHEMICAL FACTORS AFFECTING FISH ...1.0246
CONTAMINATION OF CHANNEL CATFISH WITH DIELDRIN FROM AGRICULTURAL RUNOFF ...1.0247
PESTICIDE CONTAMINATION OF ENVIRONMENT ...1.0250
TOXICITY OF POLLUTANTS TO STRIPED BASS ...1.0251
THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...1.0253
PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES ...1.0254
RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...1.0256
FIELD STUDIES OF PESTICIDE EFFECTS ON FISHES ...1.0257
LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES ...1.0258
QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...1.0259
BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH ...1.0261
MAGNITUDE AND NATURE OF POLYCHLORINATED BIPHENYLS IN COHO SALMON ...1.0262
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0265
PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269

EFFECTS OF PARATHION AND MALATHION ON WARM-WATER FISH PONDS ...1.0283
UPTAKE, PERSISTENCE AND METABOLITES OF SEVIN BY CHANNEL CATFISH ...1.0284
PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0288
UPTAKE AND METABOLISM BY FISH OF 2,4-D DIMETHYL AMINE SALT ...1.0293
CONTINUOUS-FLOW BIOASSAY OF PESTICIDES TO EVALUATE THE ACUTE AND CHRONIC EFFECTS OF PESTICIDES TO FRESHWATER INVERTEBRATES ...1.0294
THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...1.0297
THE RELATIONSHIP BETWEEN THE USE OF AGRICULTURAL CHLORINATED HYDROCARBONS AND THEIR RESIDUES IN CHANNEL CATFISH ...1.0298
ACCUMULATION OF PESTICIDES IN MENHADEN ...1.0299
THE EFFECT OF DIELDRIN ON SURVIVAL AND DEVELOPMENT OF FISH EGGS ...1.0300
THE UPTAKE OF DIELDRIN IN THE THREE RIDGED NAIAD, AMBLEMA PLICATA ...1.0301
BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...1.0303
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0304
EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0305
PESTICIDE TOXICITY TO MARINE FISH AND INVERTEBRATES ...1.0307
EFFECT OF PESTICIDE RESIDUES ON GAME FISH POPULATIONS ...1.0310
ELIMINATE OR REDUCE EFFECTS OF PESTICIDE RESIDUES ...1.0311
SUBLETHAL AMOUNTS OF ORGANIC INSECTICIDES AND FISH ...1.0313
REPRODUCTIVE PERFORMANCE OF FISH-EATING BIRDS IN NORTHERN CALIFORNIA ...1.0320
PESTICIDES AND WILDLIFE ...1.0324
SELECTED PESTICIDES VS. WILDLIFE IN AQUATIC ENVIRONMENTS ...1.0325
PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ..1.0328
FATE OF AQUATIC HERBICIDES IN THE AQUATIC ENVIRONMENT ...1.0329
THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0330
ILLINOIS LAWS AFFECTING AGRICULTURE ...1.0332
DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...1.0333
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0334
IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS ...1.0335
AN INVESTIGATION OF THE EFFECTS OF DDT AND OTHER CHLORINATED HYDROCARBONS ON THE GROWTH OF EURYHALINE MICROALGAE ...1.0336
STUDY OF CHRONIC TOXICITY OF LINDANE TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0337
MECHANISMS OF PESTICIDE ACCUMULATION IN AQUATIC ORGANISMS ...1.0338
ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...1.0339
BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342
TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...1.0344
SELECTED PESTICIDES IN AQUATIC FUNGI IN THE THREE RIVERS AREA ...1.0345
TOXICITY HAZARD OF POLYCHOLORINATED BIPHENYLS TO AQUATIC LIFE ...1.0347
INFLUENCE OF PROTOZOAN ACTIVITY ON HALOGENATED HYDROCARBON RESIDUES - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0349
STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970 ...1.0354
RESPIRATION RATES OF FISH-FOOD INVERTEBRATES EXPOSED TO PESTICIDES ...1.0355
STUDY OF CHRONIC TOXICITY OF PARATHION TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0357
PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...1.0358
ENVIRONMENTAL TOXICOLOGY OF PESTICIDES ...1.0361
INTERCEPTION AND DEGRADATION OF PESTICIDES BY AQUATIC ALGAE ...1.0363
CHEMICAL BIOCIDES IN LAKES ...1.0364
THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...1.0365
PESTICIDE LEVELS IN BIRDS WINTERING ON LAKE MICHIGAN ...1.0367
CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...2.0101
PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105
AROMATIC SOLVENT AQUATIC HERBICIDES AND EMULSIFYING AGENT TESTING ...2.0107
HERBICIDE RESIDUES ...2.0109
AQUATIC PEST CONTROL ...2.0112
AQUATIC PLANT CONTROL ...2.0128
THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...2.0150
RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...2.0161
INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...2.0167
METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186
ASSESSMENT OF LAKE TROUT RESTORATION IN MICHIGAN WATERS OF LAKE MICHIGAN, 1969-70 ...2.0202
THE EFFICACY OF MONSANTO NO. 51294 AS A FISH TOXICANT (LABORATORY) ...2.0243
CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS ...2.0265
ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...4.0007
INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...4.0027
LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN ...4.0082

Animal Wastes - Feed Lots

ECONOMIC EFFECTS OF PESTICIDES AND OTHER WASTES ON NATURAL RESOURCE QUALITY ...1.0026
QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204

Biological Organisms

AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117

Algal Pollutant Sources

MICROBIOLOGY OF FARM PONDS ...1.0220
DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...2.0094
INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106
A STUDY OF INHIBITORY COMPOUNDS PRODUCED BY FRESH-WATER ALGAE ...2.0138
ALGAE CONTROL BY ARTIFICIAL MIXING IN LAKE COCHITUATE ...2.0149
EVALUATION OF POND CONDITIONS FOLLOWING FERTILIZATION ...2.0153
EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...2.0165
EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168
EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...2.0171

EUTROPHICATION - PILOT OPERATIONS ...**2.0172**
NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...**2.0180**
LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...**2.0184**
RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY ...**4.0002**
ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...**4.0007**
EUTROPHICATION OF IOWA LAKES AND STREAMS ...**4.0008**
OCCURRENCE OF FILAMENTOUS SLIMES ORGANISMS BELOW OUTFALLS ...**4.0009**
AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...**4.0011**
NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...**4.0015**
PHYTOPLANKTON NUTRITION AND PHOTOSYNTHESIS IN EUTROPHIC LAKES ...**4.0016**
A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...**4.0018**
RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...**4.0019**
STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...**4.0022**

Animal Pollutant Sources
ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...**4.0069**

Bacterial Pollutant Sources
PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...**1.0032**
INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...**1.0116**
EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...**1.0155**
DEVELOP IN-HOUSE CAPABILITY IN WATER QUALITY TECHNIQUES FOR ANALYSES OF HEAVY METALS, BACTERIA, AND PESTICIDE RESIDUES ...**1.0171**
GROUND AND SURFACE WATERS - POLLUTION ...**1.0182**
QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...**1.0187**
QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...**1.0204**
ELECTROPHORETIC CLARIFICATION OF WATER ...**1.0211**
SOURCES OF QUALITY IMPAIRMENT OF SURFACE WATERS ...**1.0218**
MICROBIOLOGY OF FARM PONDS ...**1.0220**
VIBRIO PARAHAEMOLYTICUS IN CHESAPEAKE BAY - ISOLATION, INCIDENCE AND PATHOGENICITY ...**3.0026**
OCCURRENCE OF FILAMENTOUS SLIMES ORGANISMS BELOW OUTFALLS ...**4.0009**

Plant Pollutants
EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...**1.0319**
AQUATIC WEED CONTROL RESEARCH ...**2.0100**
AQUATIC PLANT CONTROL ...**2.0128**
CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...**2.0154**
EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...**2.0170**
IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...**2.0181**
IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION ...**2.0182**
CHANGES IN WATER ENVIRONMENT RESULTING FROM AQUATIC PLANT CONTROL ...**2.0183**
CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...**2.0185**
TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ...**4.0030**

Domestic Wastes
GREEN BAY RESEARCH PROGRAM ...**1.0112**
DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...**1.0183**

Sanitary Landfills
NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...**4.0015**

Sewage
POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...**1.0036**
PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...**1.0166**
GROUND AND SURFACE WATERS - POLLUTION ...**1.0182**
PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...**1.0199**
MICROBIOLOGY OF FARM PONDS ...**1.0220**
BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...**1.0303**
INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...**4.0001**
OCCURRENCE OF FILAMENTOUS SLIMES ORGANISMS BELOW OUTFALLS ...**4.0009**
PHYTOPLANKTON NUTRITION AND PHOTOSYNTHESIS IN EUTROPHIC LAKES ...**4.0016**

Effluents, -waste Water
PHOTOCHEMICAL METHODS FOR PURIFYING WATER ...**1.0115**
INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...**1.0116**
WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...**1.0162**
GROUND AND SURFACE WATERS - POLLUTION ...**1.0182**
TOXICITY OF POLLUTANTS TO STRIPED BASS ...**1.0251**
PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...**1.0328**
INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...**4.0001**

Industrial Wastes
CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...**1.0093**
GREEN BAY RESEARCH PROGRAM ...**1.0112**
DETECTION AND IDENTIFICATION OF MOLECULAR WATER POLLUTANTS BY LASER RAMAN SPECTROSCOPY ...**1.0151**
DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...**1.0183**
DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...**1.0184**
TOXICITY OF POLLUTANTS TO STRIPED BASS ...**1.0251**
EFFECTS OF TOXICANTS UPON FISH MOVEMENT PATTERNS ...**1.0308**
DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...**1.0333**

Mans Activities
GREEN BAY RESEARCH PROGRAM ...**1.0112**
EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...**1.0133**
GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...**1.0152**
AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...**1.0161**
REPRODUCTIVE PERFORMANCE OF FISH-EATING BIRDS IN NORTHERN CALIFORNIA ...**1.0320**

Nutrients
NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...**1.0027**
NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...**1.0029**
ENVIRONMENTAL BIOLOGY - BIOGEOCHEMICAL CYCLING IN ECOLOGICAL SYSTEMS ...**1.0068**
GREEN BAY RESEARCH PROGRAM ...**1.0112**
PREDICTING MINERAL QUALITY OF RETURN FLOW WATER ...**1.0122**

UPPER ST. JOHNS RIVER BASIN WATER QUALITY, FLORIDA ...1.0134

RURAL RUNOFF CONTROL ...1.0135

POLLUTION LOADS IN RUNOFF FROM SMALL AGRICULTURAL WATERSHEDS ...1.0154

LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION ...1.0178

GROUND AND SURFACE WATERS - POLLUTION ...1.0182

AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...1.0186

QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204

AQUATIC PLANT CONTROL BY HERBIVOROUS AMUR FISH ...2.0092

DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...2.0094

ALGAE CONTROL BY ARTIFICIAL MIXING IN LAKE COCHITUATE ...2.0149

CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...2.0154

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168

EUTROPHICATION - EFFECT OF WEED HARVESTING ...2.0169

CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...2.0185

EUTROPHICATION OF IOWA LAKES AND STREAMS ...4.0008

NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...4.0015

PHYTOPLANKTON NUTRITION AND PHOTOSYNTHESIS IN EUTROPHIC LAKES ...4.0016

RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...4.0019

NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE ...4.0025

EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029

TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ...4.0030

Organic Matter

ECONOMIC EFFECTS OF PESTICIDES AND OTHER WASTES ON NATURAL RESOURCE QUALITY ...1.0026

ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120

ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...1.0153

PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN ...1.0213

DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...1.0333

ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...4.0069

Petroleum Wastes - Spillage

AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117

DETECTION AND IDENTIFICATION OF MOLECULAR WATER POLLUTANTS BY LASER RAMAN SPECTROSCOPY ...1.0151

TOXICITY OF POLLUTANTS TO STRIPED BASS ...1.0251

Saline Water Intrusion

WATER MANAGEMENT IN MOSQUITO IMPOUNDMENTS ...2.0064

Sediments

CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...1.0024

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...1.0032

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...1.0052

EVALUATION AND DEMONSTRATION OF IRRIGATION METHODS AND PRACTICES TO REDUCE CONTAMINATION IN IRRIGATION WASTE WATER ...1.0104

COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...1.0125

EFFLUENT INFLUENCES OF THE MISSISSIPPI RIVER ON THE CHEMISTRY AND BIOLOGY OF ADJACENT OCEAN SYSTEMS ...1.0130

THE FACTOR CONTROLLING THE DYNAMICS OF NON-IONIC SYNTHETIC ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS ...1.0148

PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...1.0170

FERTILIZERS AND SEDIMENTS AS WATER POLLUTANTS ...1.0179

GROUND AND SURFACE WATERS - POLLUTION ...1.0182

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0192

RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION ...1.0194

PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...1.0199

ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211

DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215

SOURCES OF QUALITY IMPAIRMENT OF SURFACE WATERS ...1.0218

INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0223

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...1.0328

ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...1.0339

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168

CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...2.0185

INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...4.0027

Surfactants

MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS ...1.0028

DETECTION AND IDENTIFICATION OF MOLECULAR WATER POLLUTANTS BY LASER RAMAN SPECTROSCOPY ...1.0151

DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...1.0333

Thermal Pollution

MULTI-DISCIPLINARY RESEARCH IN POLLUTION ...1.0070

ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN ...1.0132

PHYSICAL AND CHEMICAL FACTORS AFFECTING FISH ...1.0246

PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...3.0047

EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...3.0089

Polychlorinated Biphenyl Cpds.

ANALYTICAL METHODS FOR PESTICIDES IN SOIL AND WATER ...1.0018

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019

PESTICIDE RESIDUES IN KANSAS STREAMS ...1.0150

PREPARATION OF CHLORINE-36 LABELED ORGANOCHLORINE PESTICIDES AND RELATED COMPOUNDS (PCB'S) ...1.0174

CHLORINATED ORGANIC CONTAMINANTS IN THE MILWAUKEE RIVER ...1.0226

CURRENT FISH AND WILDLIFE PESTICIDE PROBLEMS ...1.0235

MAGNITUDE AND NATURE OF POLYCHLORINATED BIPHENYLS IN COHO SALMON ...**1.0262**

SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA - CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...**1.0268**

THYROIDAL I125 UPTAKE IN IMMATURE CHANNEL CATFISH FOLLOWING EXPOSURE TO SELECTED TOXICANTS ...**1.0272**

TOXICITY HAZARD OF POLYCHOLORINATED BIPHENYLS TO AQUATIC LIFE ...**1.0347**

THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM ...**1.0350**

BIODEGRADATION OF PESTICIDES IN A FRESHWATER ECOSYSTEM - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0352**

Ponds -see Farm Ponds

MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...**1.0099**

METABOLISM OF ENDRIN IN PONDS ...**1.0113**

ADSORPTION OF PESTICIDES FROM SEA WATER ...**1.0159**

TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE ...**1.0201**

CHRONIC EFFECTS OF DURSBAN ON WARM-WATER FISH ...**1.0282**

EFFECTS OF PARATHION AND MALATHION ON WARM-WATER FISH PONDS ...**1.0283**

POND ECOLOGY AND PRODUCTION AS AFFECTED BY SIMAZINE ...**1.0353**

ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...**2.0001**

BIOLOGICAL AND BIOCHEMICAL FACTORS INFLUENCING THE DEVELOPMENT OF LARVAL MOSQUITO POPULATIONS ...**2.0052**

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...**2.0079**

AQUATIC PLANT CONTROL BY HERBIVOROUS AMUR FISH ...**2.0092**

CHEMICAL CONTROL OF WEEDS IN PONDS ...**2.0093**

PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...**2.0105**

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEFDS IN THE SOUTHEAST ...**2.0118**

MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...**2.0124**

TESTING OF NEW HERBICIDES ...**2.0125**

TESTING OF METHODS OF HERBICIDE APPLICATION ...**2.0126**

SURVEY OF POND WEEDS AND PLANT SUCCESSION ...**2.0127**

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0129**

AQUATIC WEED CONTROL BY POND FISHES ...**2.0139**

FOREST AND FARM GAME HABITAT; FISH POND ...**2.0143**

EVALUATION OF POND CONDITIONS FOLLOWING FERTILIZATION ...**2.0153**

CONTROL OF UNDESIRABLE AQUATIC VEGETATION ...**2.0155**

BIOLOGY AND CONTROL OF AQUATIC WEEDS ...**2.0162**

NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...**2.0188**

JO-MARY POND RECLAMATION ...**2.0201**

SELECTIVE REMOVAL OF VARIOUS FISH SPECIES WITH ANTIMYCIN ...**2.0240**

EPIZOOTIOLOGY OF PARASITIC DISEASES IN FISH POPULATIONS UNDER INTENSIVE MANAGEMENT ...**3.0001**

COOPERATIVE FISH DISEASE PROJECT ...**3.0012**

ENVIRONMENTAL STUDY ...**3.0030**

INVESTIGATION OF HANDLING TECHNIQUES ...**3.0111**

RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...**4.0019**

EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...**4.0023**

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0024**

FISHERIES INVESTIGATIONS WITH SPECIAL REFERENCE TO MANAGEMENT OF ECONOMIC SPECIES ...**4.0080**

Porifera

AQUATIC WEED CONTROL RESEARCH ...**2.0100**

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...**2.0104**

MOLLUSCAN MORTALITY STUDIES ...**3.0032**

Porosity, Permeability

DEVELOPMENT OF FIELD METHODS IN SAMPLING WATER FOR PESTICIDE ANALYSIS ...**1.0173**

Potable Water

INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...**1.0116**

EFFECTIVENESS OF IODINE FOR DISINFECTION OF PUBLIC WATER SUPPLIES & TO DETERMINE PHYSIOLOGICAL EFFECTS ON A HUMAN POPULATION ...**1.0126**

GROUND AND SURFACE WATERS - POLLUTION ...**1.0182**

FATE OF AQUATIC HERBICIDES IN THE AQUATIC ENVIRONMENT ...**1.0329**

Pre-impoundment Sites

BIOLOGICAL AND LIMNOLOGICAL INVENTORY OF SEVEN FLOOD CONTROL RESERVOIRS IN THE STATE OF INDIANA ...**2.0199**

IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...**3.0018**

Precipitation

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...**1.0191**

Rain

WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...**1.0005**

DISPOSITION OF PESTICIDES IN THE SOIL ...**1.0031**

WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...**1.0050**

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...**1.0052**

EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...**1.0074**

PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...**1.0090**

MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...**1.0099**

EFFECT OF PESTICIDES ON THE QUALITY OF SURFACE AND GROUND WATERS IN THE WESTERN GULF REGION ...**1.0101**

CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...**1.0189**

INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...**2.0025**

SURVEY OF INSECT PROBLEMS IN MONTANA ...**2.0059**

MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...**2.0060**

Snow

DDT IN SNOW FALLEN AT HIGH ALTITUDE SINCE 1950 ...**1.0214**

Processing & Preservation

Canning

REDUCTION OF PESTICIDE RESIDUE HAZARDS ...1.0040

Drying

HISTOPATHOLOGY OF LIVERS OF RAINBOW TROUT FED RANCID PELLETS CONTAINING AFLATOXIN ...3.0081

Freezing

QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...1.0259

VERTEBRATE DISEASES - VIRAL DISEASES OF FRESHWATER FISHES AND OTHER LOWER VERTEBRATES EGTVED VIRUS ...3.0104

Mechanical Processing

TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...1.0344

Pelleted

HISTOPATHOLOGY OF LIVERS OF RAINBOW TROUT FED RANCID PELLETS CONTAINING AFLATOXIN ...3.0081

Product Development Research

New Ag Uses of Industrial Prod

DEVELOPMENT OF TREATMENT PROCESS FOR CHLORINATED HYDROCARBON PESTICIDE MANUFACTURING AND PROCESSING WASTES ...1.0118

AROMATIC SOLVENT AQUATIC HERBICIDES AND EMULSIFYING AGENT TESTING ...2.0107

ROTENOIDS FROM TEPHROSIA VOGELII ...2.0198

New Ag Uses of Nat. Resources

FISHERY RESOURCES PROGRAM ...1.0317

ALLEVIATION OF LAKE POLLUTION BY UTILIZATION OF AQUATIC PLANTS FOR NUTRITIONAL, MEDICINAL OR INDUSTRIAL PURPOSES ...2.0152

New Uses of Ag Products

PROCESSING, CHEMICAL COMPOSITION, AND NUTRITIVE VALUE OF AQUATIC WEEDS ...2.0119

ALLEVIATION OF LAKE POLLUTION BY UTILIZATION OF AQUATIC PLANTS FOR NUTRITIONAL, MEDICINAL OR INDUSTRIAL PURPOSES ...2.0152

IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...2.0181

Proteins

RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...1.0057

QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...1.0259

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269

SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0273

PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...1.0289

PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...1.0290

ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...1.0339

BIOLOGICAL CONTROL OF WEEDS ...2.0099

EVALUATION OF STRESS IN FINGERLING SALMON THERAPEUTIC DRUGS AS STRESS FACTORS ...3.0120

INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...4.0001

LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010

Antigen

ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - FURUNCULOSIS IN COHO SALMON ...3.0122

Azoproteins

ANALYTICAL METHODS FOR PESTICIDES AND PESTICIDE DEGRADATION PRODUCTS ...1.0088

Bactericidins

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

Blood Proteins

ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...1.0339

EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...3.0089

Creatinine

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0269

SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0273

EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...2.0234

Gluten

NUTRITIONAL FACTORS IN THE DEVELOPMENT OF CORYNEBACTERIAL KIDNEY DISEASE ...3.0090

Lipoproteins

DEVELOPMENTS OF METHODS RELATED TO TESTING OF FISH CONTROL AGENTS BIOCHEMICAL METHOD FOR SEXING FISH ...2.0248

Phosphoproteins

DEVELOPMENTS OF METHODS RELATED TO TESTING OF FISH CONTROL AGENTS BIOCHEMICAL METHOD FOR SEXING FISH ...2.0248

Plant Proteins -general

GROWTH REGULATORS AND MINERAL NUTRITION IN AQUATIC PLANT CONTROL ...2.0134

A STUDY OF INHIBITORY COMPOUNDS PRODUCED BY FRESH-WATER ALGAE ...2.0138

Protozoa

Ciliata

Ciliata -other

MULTI-DISCIPLINARY RESEARCH IN POLLUTION ...1.0070

EPIZOOTIOLOGY OF PARASITIC DISEASES IN FISH POPULATIONS UNDER INTENSIVE MANAGEMENT ...3.0001

PARASITOLOGY - PARASITES AND PARASITIC DISEASES OF FISHES - IMMUNIZATION STUDY FOR ICHTHYOPHTHIRIUS ...3.0100

PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...3.0108

PARASITES AND PARASITIC DISEASES OF FISHES - STUDY OF NEW METHODS FOR CONTROL OF ICHTHYOPHT ...3.0128

Tetrahymena

BIOLOGY AND BIOLOGICAL CONTROL OF SCHISTOSOMIASIS ...2.0277

Cnidosporidia

Cnidosporidia -other

FACTORS AFFECTING ROLE OF MICROORGANISMS IN BIOLOGICAL CONTROL OF INSECT PESTS ...2.0037

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...**3.0029**

INFECTIOUS DISEASES OF SALMONID FISHES ...**3.0049**

BIOLOGY OF THE PROTOZOAN PARASITE CERATOMYXA SHASTA ...**3.0050**

IMPACT OF CERATOMYXA IN CENTRAL OREGON SALMONID POPULATIONS ...**3.0057**

TRANSMISSION OF CERATOMYXA SHASTA ...**3.0058**

PATHOLOGY - EPIZOOTIOLOGY ...**3.0113**

DISEASE-RESISTANT OYSTERS ...**3.0114**

TRANSMISSION OF MICROSPORIDA ...**3.0131**

Myxosoma

USE OF CELL CULTURE METHODS TO ATTEMPT TO FOLLOW DEVELOPING STAGES OF SPORES ...**3.0062**

SUSCEPTIBILITY OF VARIOUS AGES OF FISH TO INFECTION ...**3.0063**

UTILIZATION OF INVERTEBRATE VECTORS IN THE TRANSMISSION OF WHIRLING DISEASE ...**3.0064**

USE OF TISSUE SECTIONING TECHNIQUES TO ATTEMPT TO FOLLOW THE LIFE HISTORY OF WHIRLING DISEASE PARASITES FROM THE FIRST DAY OF INFECTION ...**3.0065**

TREATMENT OF WHIRLING DISEASE SPORES TO PRODUCE INFECTIVE STATES OF THE ORGANISM ...**3.0066**

METHODS OF COLLECTING AND CONCENTRATING SPORES TAKEN FROM INFECTED FISH ...**3.0067**

DETERMINE IF SPORES OR INFECTIVE STAGES ARE SHED FROM LIVING FISH ...**3.0068**

ISOLATION AND FURTHER DESCRIPTION OF THE SPORES OF MYXOSOMA CEREBRALIS ...**3.0101**

LONGEVITY OF SPORES OF 'MYOXOSOMA CEREBRALIS' (WHIRLING DISEASE) ...**3.0102**

IMMUNODIAGNOSIS OF WHIRLING DISEASE (MYXOSOMA CEREBRALIS) ...**3.0103**

POSSIBLE BIRD TRANSMISSION OF 'MYXOSOMA CEREBRALIS' ...**3.0105**

CONTROL OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA FILTRATION AND ULTRAVIOLET IRRADIATION ...**3.0129**

EFFECT OF DISINFECTING AGENTS ON M. CEREBRALIS ...**3.0130**

TRANSMISSION OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA ...**3.0132**

Nosema

BIOLOGICAL CONTROL OF INSECTS AFFECTING MAN ...**2.0027**

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS ...**2.0033**

Flagellata

Trypanosoma

INSECTS AS VECTORS OF DISEASES OF MILITARY IMPORTANCE IN ETHIOPIA THEIR ECOLOGY AND CONTROL ...**4.0067**

Protozoa -other

INFLUENCE OF PROTOZOAN ACTIVITY ON HALOGENATED HYDROCARBON RESIDUES - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0349**

INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...**1.0351**

TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...**2.0007**

INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...**2.0029**

FACTORS AFFECTING ROLE OF MICROORGANISMS IN BIOLOGICAL CONTROL OF INSECT PESTS ...**2.0037**

FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...**2.0053**

MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...**2.0062**

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...**2.0079**

SCHISTOSOME CONTROL BY TREMATODE ANTAGONISM ...**2.0270**

BIOLOGY AND BIOLOGICAL CONTROL OF SCHISTOSOMIASIS ...**2.0277**

STUDY OF THE INCIDENCE AND LIFE CYCLES OF MYXOSPORIDIAL INFECTIONS IN WARM WATER FISHES (REVISED) ...**3.0020**

MOLLUSCAN MORTALITY STUDIES ...**3.0032**

TRANSMISSION OF AN OVARY PARASITE OF THE GOLDEN SHINER ...**3.0038**

PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...**3.0047**

TESTING OF STOCKS OF OYSTERS FOR DISEASE RESISTANCE ...**3.0077**

ACQUIRED VS. GENETIC RESISTANCE IN OYSTERS ...**3.0078**

TESTS OF SELECTED SEED OYSTER STOCKS ON COMMERCIAL BEDS ...**3.0079**

CONTROL OF MYXOSPORIDIAN PARASITES ...**3.0109**

RELATIONSHIP OF TEMPERATURE TO DISEASES OF SALMONID FISH ...**3.0116**

Sarcodina

Amoeba

INVESTIGATIONS OF AMEBIASIS IN FISH ...**3.0014**

Sporozoa

Coccidia

MOLLUSCAN MORTALITY STUDIES ...**3.0032**

Plasmodia

MALARIA ERADICATION RESEARCH ...**2.0051**

CULTIVATION OF INSECT PHASE OF AVIAN PLASMODIA ...**4.0036**

ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...**4.0046**

Sporozoa -other

MOLLUSCAN MORTALITY STUDIES ...**3.0032**

Publications

STUDIES ON SOME FUNGAL PARASITES OF MOSQUITOES ...**2.0072**

EUROPEAN SCIOMYZIDAE ...**2.0283**

MOSQUITOES OF MIDDLE AMERICA ...**4.0037**

Bibliography

CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...**1.0093**

CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...**1.0210**

PUBLICATION OF BIBLIOGRAPHY OF MEDICAL ENTOMOLOGY ...**4.0042**

Catalogs, Tables, Compilations

DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...**1.0333**

Handbooks

METHODS FOR DISPOSAL OF SPILLED AND UNUSED PESTICIDES ...**1.0060**

DEVELOPMENT OF ANALYTICAL METHODS FOR SELECTED HERBICIDES ...**1.0175**

UPDATING THE 'HANDBOOK OF PROCEDURES FOR PESTICIDE RESIDUE ANALYSIS' - METHODOLOGY IN CHEMICAL ANALYSIS AND SAMPLING ...**1.0176**

AQUATIC PLANTS OF POLLUTED WATERS IN SOUTHWESTERN UNITED STATES ...**4.0028**

Monograph

MOSQUITOES OF MIDDLE AMERICA ...**4.0038**

MOSQUITOES OF THE NEW GUINEA AREA ...**4.0050**

Periodicals, Journals

THE RELATIONSHIP BETWEEN THE USE OF AGRICULTURAL CHLORINATED HYDROCARBONS AND THEIR RESIDUES IN CHANNEL CATFISH ...**1.0298**

ANALYSIS OF DATA AND PREPARATION OF MANUSCRIPTS FOR PUBLICATION ...**3.0044**

PUBLICATION OF BIBLIOGRAPHY OF MEDICAL ENTOMOLOGY ...**4.0042**

Puget Sound

EPIDERMAL PAPILLOMAS ...**3.0021**

Pumping

FATE OF POLLUTANTS IN GROUND WATER ...**1.0079**
PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...**1.0094**
EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...**1.0100**

Pyrrolizidine

BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...**2.0057**

Pyruvic Acid

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...**2.0043**

Quality Evaluation of Feed

PROCESSING, CHEMICAL COMPOSITION, AND NUTRITIVE VALUE OF AQUATIC WEEDS ...**2.0119**
DEVELOPMENT OF METHODS FOR COMMERCIAL PRODUCTION OF FROG LEGS FROM TADPOLES OF THE BULLFROG ...**3.0028**

Quarantine &/or Inspection

PACIFIC OYSTER MORTALITY STUDIES ...**3.0034**

Radiation Effects

GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...**2.0034**
RADIATION CYTOGENETICS OF THE YELLOW-FEVER MOSQUITO, AEDES AEGYPTI ...**2.0036**

Radiations

REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0046**
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...**1.0191**
GENETIC CONTROL OF ANOPHELINES USING TRANSLOCATIONS ...**2.0034**

Infra Red

INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...**2.0030**

Microwave and Radiofrequency

MICROWAVE-EXCITED EMISSION DETECTOR FOR PESTICIDES AND TRACE METAL ANALYSIS ...**1.0195**

Ultra Violet

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...**1.0319**
INFECTIOUS DISEASES OF SALMONID FISHES ...**3.0049**
CONTROL OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA FILTRATION AND ULTRAVIOLET IRRADIATION ...**3.0129**

Range

WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...**1.0005**

Rates, Doses, Concentrations

THYROIDAL I125 UPTAKE IN IMMATURE CHANNEL CATFISH FOLLOWING EXPOSURE TO SELECTED TOXICANTS ...**1.0272**

Absorption Rates

MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS ...**1.0028**
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0034**

Application Rates

TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...**1.0056**
PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS ...**1.0063**
MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...**1.0071**
PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...**1.0090**
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...**1.0091**
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...**1.0145**
RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...**1.0146**
DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...**1.0196**
PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...**1.0289**
AERIAL DISPERSAL METHODS FOR CONCENTRATED INSECTICIDES ...**2.0009**
INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...**2.0025**
EMERGENCY INSECT CONTROL ...**2.0076**
WEED CONTROL IN RICE PRODUCTION ...**2.0097**
AQUATIC WEED CONTROL RESEARCH ...**2.0100**
WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...**2.0104**
EFFECT OF COPPER SULFATE ON AQUATIC WEEDS ...**2.0108**
GROWTH SUPPRESSION AND REDUCTION IN REGROWTH POTENTIAL OF AQUATIC WEEDS ...**2.0110**
AQUATIC PEST CONTROL ...**2.0112**
CONTROL OF AQUATIC WEEDS ...**2.0113**
CHEMICAL CONTROL OF DITCHBANK WEEDS IN PEAT AND SANDY SOIL AREAS OF SOUTH FLORIDA ...**2.0114**
BIOLOGY AND CONTROL OF AQUATIC WEEDS ...**2.0162**
WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...**2.0176**
ALGACIDES FOR USE IN WATER RECLAMATION AND REUSE SYSTEMS ...**2.0177**
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...**2.0178**
CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...**2.0187**
DEVELOPMENT OF ACCURATE CHEMICAL INTRODUCTION TECHNIQUES ...**2.0223**
THE EFFICACY OF MONSANTO NO. 51294 AS A FISH TOXICANT (LABORATORY) ...**2.0243**
BIOLOGY AND CONTROL OF SNAILS ...**2.0268**

Formulation,rate,concentration

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0006**
INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...**1.0015**
RESPROUTING OF CHAPARRAL ...**1.0017**
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0023**
REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...**1.0047**
MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...**1.0071**

SOILS, PESTICIDES, AND THE QUALITY OF WATER ...**1.0103**

ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...**1.0106**

DEVELOPMENT OF ON-SITE BIOASSAY METHODS ...**1.0108**

UPTAKE AND RELEASE OF DALAPON IN EARTHEN PONDS ...**1.0114**

CONCENTRATION AND ANALYSIS OF PESTICIDES AND OTHER RECALCITRANT MOLECULES IN WATER SUPPLIES BY ULTRAFILTRATION ...**1.0185**

THE BIOASSAY OF WATER POLLUTANTS WITH CULTURED MAMMALIAN CELLS ...**1.0200**

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...**1.0249**

LABORATORY BIOASSAYS TO DETERMINE TOXIC EFFECS OF METHOXYCHLOR IN FISH ...**1.0264**

CHRONIC EFFECTS OF DURSBAN ON WARM-WATER FISH ...**1.0282**

UPTAKE AND METABOLISM BY FISH OF 2,4-D DIMETHYL AMINE SALT ...**1.0293**

STATIC BIOASSAY OF TRACERS AND DYES AGAINST FISH AND INVERTEBRATES ...**1.0316**

STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970 ...**1.0354**

STUDY ON THE EFFECTS OF FISH TOXICANTS ANTIMYCIN A AND ROTENONE ON POND COMMUNITIES ...**1.0366**

MALARIA ERADICATION RESEARCH ...**2.0051**

NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...**2.0077**

AQUATIC WEED CONTROL RESEARCH ...**2.0100**

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...**2.0104**

EFFECT OF COPPER SULFATE ON AQUATIC WEEDS ...**2.0108**

CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...**2.0154**

EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP, SOFT-WATER LAKES ...**2.0213**

PISCICIDE TOXICOLOGY OF THE CYPRINIDS IN EAST AND WEST PAULINA LAKES ...**2.0228**

EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT) ...**2.0229**

U.V. SPECTROPHOTOMETRY FOR THE IDENTIFICATION AND ESTIMATION OF QUINALDINE RESIDUE ...**2.0237**

ESTABLISH MINIMUM DOSES OF ANTIMYCIN AND ROTENONE NEEDED FOR TOTAL KILLS OF TARGET FISHES ...**2.0247**

STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...**2.0255**

STATIC BIOASSAY OF COLLECTING AIDS AGAINST FISH ...**2.0257**

STATIC BIOASSAY OF ATTRACTANTS AND REPELLANTS AGAINST FISH AND INVERTEBRATES ...**2.0258**

THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...**2.0261**

CONTROL OF MYXOSPORIDIAN PARASITES ...**3.0109**

Rates -other

IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS ...**1.0335**

Tolerance Rates

REDUCTION OF PESTICIDE RESIDUE HAZARDS ...**1.0040**

PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...**1.0090**

THE OCCURRENCE OF PESTICIDE RESIDUES IN THE LOWER BRISBANE RIVER AND IN THE TISSUES OF ESTUARINE ANIMALS ...**1.0233**

EFFECTS OF PESTICIDES ON AQUATIC ANIMALS IN THE ESTUARINE AND MARINE ENVIRONMENTS ...**1.0234**

BEHAVIOR OF ESTUARINE ANIMALS ...**1.0240**

LABORATORY BIOASSAYS ...**1.0241**

THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...**1.0253**

LABORATORY BIOASSAYS TO DETERMINE TOXIC EFFECS OF METHOXYCHLOR IN FISH ...**1.0264**

SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA - CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...**1.0268**

THYROIDAL I125 UPTAKE IN IMMATURE CHANNEL CATFISH FOLLOWING EXPOSURE TO SELECTED TOXICANTS ...**1.0272**

THE SUSCEPTIBILITY OF VARIOUS LIFE STAGES OF FRESHWATER FISHES TO THREE TOXICANTS ...**1.0279**

RELATIVE SUSCEPTIBILITIES OF FISH FAMILIES TO HERBICIDES ...**1.0280**

CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...**1.0285**

PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...**1.0290**

CONTINUOUS-FLOW BIOASSAY OF PESTICIDES TO EVALUATE THE ACUTE AND CHRONIC EFFECTS OF PESTICIDES TO FRESHWATER INVERTEBRATES ...**1.0294**

STATIC BIOASSAY OF TRACERS AND DYES AGAINST FISH AND INVERTEBRATES ...**1.0316**

CHRONIC TOXICITY OF PESTICIDES TO COLD-WATER FISH ...**1.0318**

AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...**1.0343**

STUDY OF CHRONIC TOXICITY OF PARATHION TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...**1.0357**

AQUATIC PLANT CONTROL ...**2.0128**

INFLUENCE OF PESTICIDES & OTHER HYDROCARBONS ON GROWTH OF EURYTOLERANT MICROALGAE ...**2.0148**

PISCICIDE TOXICOLOGY OF THE CYPRINIDS IN EAST AND WEST PAULINA LAKES ...**2.0228**

ESTABLISH MINIMUM DOSES OF ANTIMYCIN AND ROTENONE NEEDED FOR TOTAL KILLS OF TARGET FISHES ...**2.0247**

STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES ...**2.0256**

STATIC BIOASSAY OF COLLECTING AIDS AGAINST FISH ...**2.0257**

STATIC BIOASSAY OF ATTRACTANTS AND REPELLANTS AGAINST FISH AND INVERTEBRATES ...**2.0258**

CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...**2.0259**

TOXICITY OF THERAPEUTIC AGENTS TO STRIPED BASS ...**3.0112**

Rations

DEVELOPMENT OF METHODS FOR COMMERCIAL PRODUCTION OF FROG LEGS FROM TADPOLES OF THE BULLFROG ...**3.0028**

Fish Rations

NUTRITIONAL FACTORS IN THE DEVELOPMENT OF CORYNEBACTERIAL KIDNEY DISEASE ...**3.0090**

Recharge

POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...**1.0036**

FATE OF POLLUTANTS IN GROUND WATER ...**1.0079**

PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...**1.0094**

EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...**1.0100**

Recreation

GREEN BAY RESEARCH PROGRAM ...**1.0112**

Fishing

HAUL SEINE STUDY ...**2.0192**

BIOLOGICAL AND LIMNOLOGICAL INVENTORY OF SEVEN FLOOD CONTROL RESERVOIRS IN THE STATE OF INDIANA ...**2.0199**

THE INTERACTION OF THE WALLEYE AND WHITE SUCKER IN THE FISH POPULATION OF SOFT WATER LAKE IN NORTHEASTERN MINNESOTA ...2.0215

IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...3.0018

LIMNOLOGICAL, ICHTHYOLOGICAL, AND PARASITOLOGICAL INVESTIGATIONS ON ARKANSAS RESERVOIRS IN RELATION TO WATER QUALITY ...3.0019

ECOLOGY OF RECREATIONALLY IMPORTANT ESTUARINE FISHES IN OREGON ...3.0052

LIFE HISTORY OF ST. JOE RIVER CUTTHROAT TROUT ...4.0077

LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN ...4.0082

General Recreation Studies

EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029

Hunting

WATER MANAGEMENT IN MOSQUITO IMPOUNDMENTS ...2.0064

Loss Damages - Recreation

REPRODUCTIVE PERFORMANCE OF FISH-EATING BIRDS IN NORTHERN CALIFORNIA ...1.0320

Projected Demand

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161

Safety - Recreation

INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0116

AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117

INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...2.0010

SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...2.0278

Standards - Recreation

AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117

Swimming

INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0116

AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117

SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...2.0278

SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...2.0279

Touring

NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...4.0015

Recreation Sites

GREEN BAY RESEARCH PROGRAM ...1.0112

INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0116

AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161

MOSQUITO CONTROL - TIDAL MARSHES ...2.0063

METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186

NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...4.0015

EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029

Rehabilitation -streams -lakes

THE EFFICACY OF NEW FORMULATIONS OF ANTIMYCIN IN NATURAL LAKES AND STREAMS ...2.0246

EXPERIMENTAL RECLAMATION OF TROUT STREAMS THROUGH CHEMICAL TREATMENT ...2.0263

Remote Sensing

ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN ...1.0132

Em Radiation

Microwave Radiation

MICROWAVE-EXCITED EMISSION DETECTOR FOR PESTICIDES AND TRACE METAL ANALYSIS ...1.0195

From Aircraft

ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN ...1.0132

Lasers-masers

DETECTION AND IDENTIFICATION OF MOLECULAR WATER POLLUTANTS BY LASER RAMAN SPECTROSCOPY ...1.0151

Removal of Pesticide Residues

CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...1.0004

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0009

ANALYTICAL METHODS FOR PESTICIDES IN SOIL AND WATER ...1.0018

REACTIONS OF PESTICIDES WITH SOILS ...1.0020

CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...1.0024

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...1.0032

POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...1.0036

REDUCTION OF PESTICIDE RESIDUE HAZARDS ...1.0040

EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041

REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...1.0047

WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...1.0050

METHODS FOR DISPOSAL OF SPILLED AND UNUSED PESTICIDES ...1.0060

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065

INTERACTION OF HERBICIDES AND SOIL MICROORGANISMS ...1.0069

CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0093

MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099

PHOTOCHEMICAL METHODS FOR PURIFYING WATER ...1.0115

DEVELOPMENT OF TREATMENT PROCESS FOR CHLORINATED HYDROCARBON PESTICIDE MANUFACTURING AND PROCESSING WASTES ...1.0118

STUDY OF ELECTROHYDRAULIC WATER TREATMENT ...1.0121

ENVIRONMENTAL FACTORS IN THE SURVIVAL OF MAN ...1.0132

DEVELOP EFFECTIVE TREATMENT METHODS FOR HARD PESTIDICIDES ...1.0136

CHROMATOGRAPHIC CONCENTRATION OF PESTICIDES FROM A LARGE MASS OF WATER ...1.0188

DEVELOP EFFECTIVE TREATMENT METHODS FOR HARD PESTICIDES ...1.0197

QUANTITATIVE METHODS FOR PESTICIDES IN NATURAL WATERS ...1.0198

ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211

LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...1.0212

DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215

IMPROVING WATER QUALITY BY REMOVAL OF PESTICIDE POLLUTANTS WITH AQUATIC PLANTS ...1.0216

PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES ...1.0306

PESTICIDES AND WILDLIFE ...1.0324

TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...1.0344

EXPERIMENTATION WITH FINTROL AS A FISH TOXICANT IN DEEP SOFTWATER LAKES ...2.0216

TIME-CONCENTRATION TESTS INVOLVING NEUTRALIZATION OF ROTENONE WITH POTASSIUM PERMANGANATE ...2.0224

NEUTRALIZATION OF ROTENONE WITH ACTIVATED CHARCOAL ...2.0225

THE EFFICACY OF MONSANTO NO. 51294 AS A FISH TOXICANT (LABORATORY) ...2.0243

Repellents

STUDIES OF SHARK REPELLENTS AND OTHER ANTISHARK MEASURES ...2.0191

Fish Repellents

STUDIES OF SHARK REPELLENTS AND OTHER ANTISHARK MEASURES ...2.0191

STATIC BIOASSAY OF ATTRACTANTS AND REPELLANTS AGAINST FISH AND INVERTEBRATES ...2.0258

Insect Repellents

SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA - CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...1.0268

SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...2.0028

EFFECT OF BITING FLIES ON WEIGHT GAINS IN CATTLE ...2.0090

ATTRACTIVENESS AND REPELLENCY OF MAN TO MOSQUITO BITES ...4.0041

DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...4.0051

Reproductive Physiology

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0037

GEOGRAPHIC ATLAS OF PESTICIDE OCCURRENCE IN THE BARATARIA BAY-MISSISSIPPI DELTA ...1.0152

EFFECT OF ENDRIN ON EGG-SPERM FORMATION AND EMBRYONIC DEVELOPMENT ...1.0229

RELATIONSHIPS BETWEEN SUB-LETHAL PESTICIDES AND REPRODUCTION AND BEHAVIOR OF FISHES ...1.0245

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...1.0249

PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES ...1.0254

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0304

EFFECTS OF TOXICANTS UPON FISH MOVEMENT PATTERNS ...1.0308

SELECTED PESTICIDES VS. WILDLIFE IN AQUATIC ENVIRONMENTS ...1.0325

REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES ...4.0083

Artificial Insemination

SPAWNING AND REARING OF MARINE FISH ...3.0110

Embryonic Mortality

BIOLOGICAL SIGNIFICANCE OF PESTICIDE RESIDUES IN FISH ...1.0261

Female Gametes

EFFECT OF ENDRIN ON EGG-SPERM FORMATION AND EMBRYONIC DEVELOPMENT ...1.0229

Oogenesis

RELATIONSHIPS BETWEEN SUB-LETHAL PESTICIDES AND REPRODUCTION AND BEHAVIOR OF FISHES ...1.0245

Male Gametes

EFFECT OF ENDRIN ON EGG-SPERM FORMATION AND EMBRYONIC DEVELOPMENT ...1.0229

Semen and Sperm Storage

AQUICULTURE, SALMON CULTURE - RESEARCH ...3.0053

AQUICULTURE, OYSTER HATCHERIES - RESEARCH ...3.0118

Spermatogenesis

RELATIONSHIPS BETWEEN SUB-LETHAL PESTICIDES AND REPRODUCTION AND BEHAVIOR OF FISHES ...1.0245

Ovary

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...1.0236

PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES ...1.0254

DEVELOPMENTS OF METHODS RELATED TO TESTING OF FISH CONTROL AGENTS BIOCHEMICAL METHOD FOR SEXING FISH ...2.0248

TRANSMISSION OF AN OVARY PARASITE OF THE GOLDEN SHINER ...3.0038

Oviparous Reproduction

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...1.0304

INSECTICIDES AND EGG-SHELL DEPOSITION ...1.0368

Oviposition

INSECT ATTRACTANTS, BEHAVIOR AND BASIC BIOLOGY ...2.0030

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF WESTERN U.S. ...2.0079

THE CONTROL OF SLUGS ...2.0294

POPULATION DYNAMICS OF MOSQUITOES IN FLORIDA ...4.0048

Testes

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...1.0236

EFFECTS ON THE SPERMIATION RESPONSE OF GOLDFISH AFTER EXPOSURE TO SELECTED PESTICIDES ...1.0270

Reptiles

Chelonia

EVALUATION OF WATERFOWL PREDATOR CONTROL METHODS ...2.0272

EFFECTS OF A SNAPPING TURTLE POPULATION ON THE WATERFOWL PRODUCTIVITY OF A MARSH ...2.0292

ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044

Crocodilidae

ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044

Endangered Species

ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044

Reptile Studies -other

THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...1.0365

EVALUATION OF WATERFOWL PREDATOR CONTROL METHODS ...2.0272

EFFECTS OF A SNAPPING TURTLE POPULATION ON THE WATERFOWL PRODUCTIVITY OF A MARSH ...2.0292

ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044

Research Facilities

CENTER FOR STUDY OF THE HUMAN ENVIRONMENT ...1.0190

RESEARCH VESSEL OPERATIONS ...3.0048

Reservoirs and Impoundments

EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANO-TOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041

LIMNOLOGICAL FACTORS AFFECTING PESTICIDE RESIDUES IN SURFACE WATERS ...1.0149

PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...1.0170

OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...1.0219

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104

THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...2.0130

DETERMINATION OF THE EFFECTS OF A FERTILIZER-INDUCED PLANKTON TURBIDITY, SUPPLEMENTED BY HERBICIDES, ON SUBMERGED AQUATIC PLANTS ...2.0137

WATERLEVEL MANAGEMENT ON IMPOUNDMENTS OF LOW QUALITY SOILS ...2.0163

AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO ...2.0227

IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...3.0018

RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY ...4.0002

GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081

Flood Control Reservoirs

BIOLOGICAL AND LIMNOLOGICAL INVENTORY OF SEVEN FLOOD CONTROL RESERVOIRS IN THE STATE OF INDIANA ...2.0199

Wildlife Reservoirs

RESTORING 'BALANCE' WITH ROTENONE AND FINTROL ...2.0194

SURVIVAL AND GROWTH OF KOKANEE AND COHO SALMON IN ANDERSON RANCH RESERVIOR ...2.0197

EFFECTS OF WATER EXCHANGE AND BLUE CRAB CONTROL ON SHRIMP PRODUCTION IN LOUISIANA SALTMARSH IMPOUNDMENTS ...2.0275

Residues in Feeds -pesticides

PESTICIDE RESIDUES ON ARIZONA CROPS ...1.0007

REDUCTION OF PESTICIDE RESIDUE HAZARDS ...1.0040

PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES ...1.0062

PESTICIDE CONTAMINATION OF ENVIRONMENT ...1.0250

PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES ...1.0306

THE CHEMISTRY AND TOXICOLOGY OF AGRICULTURAL CHEMICALS ...1.0322

Resins

NEW OR IMPROVED TECHNIQUES FOR SAFE CHEMICAL CONTROL OF ECTOPARASITES OF DOMESTIC ANIMALS ...2.0077

MARINE PILING ANALYSIS ...2.0296

Resistance & Tolerance

Animal Resistance

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...1.0249

FACTORS AFFECTING PESTICIDE TOXICITY ...1.0255

RELATIVE SUSCEPTIBILITIES OF FISH FAMILIES TO HERBICIDES ...1.0280

STUDIES ON THE UPTAKE AND TRANSLOCATION OF C14-LABELED DDT AND ALDRIN IN INVERTEBRATE POPULATIONS, FY 1970 ...1.0354

BIOLOGY AND CONTROL OF PASTURE MOSQUITOES ...2.0008

INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...2.0010

EVALUATION OF NEW INSECTICIDES ...2.0015

STUDIES ON INSECTICIDE RESISTANCE IN MOSQUITOES ...2.0017

SUPPRESSION AND ECOLOGY OF MOSQUITOES ...2.0018

INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025

SUSCEPTIBILITY OF INSECTS TO INSECTICIDES ...2.0055

MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...2.0060

SUSCEPTIBILITY OR RESISTANCE OF MEDICALLY IMPORTANT INSECTS TO INSECTICIDES ON SELECTED AIR FORCE BASES ...2.0084

ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089

THE EFFECTS OF THANITE ON THE INORGANIC BLOOD CHEMISTRIES OF FISHES ...2.0253

THE EFFECTS OF THANITE ON THE ACID-BASE BALANCE IN THE BLOOD OF FISHES ...2.0254

EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH ...2.0260

CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS ...2.0265

MOLLUSCICIDES - A CORRELATION OF STRUCTURE VS. ACTIVITY ...2.0291

BIOCHEMICAL CHANGES IN FISH DISEASES - THE STRESS OF FORMALIN TREATMENTS IN SALMONID FISHES ...3.0124

DEVELOPMENT OF CULTURE METHODS FOR MOSQUITOES ...4.0035

RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070

Plant Resistance

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082

AN INVESTIGATION OF THE EFFECTS OF DDT AND OTHER CHLORINATED HYDROCARBONS ON THE GROWTH OF EURYHALINE MICROALGAE ...1.0336

WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...2.0179

Respiratory Techniques

RESPIRATION RATES OF FISH-FOOD INVERTEBRATES EXPOSED TO PESTICIDES ...1.0355

Reverse Osmosis

CONCENTRATION AND ANALYSIS OF PESTICIDES AND OTHER RECALCITRANT MOLECULES IN WATER SUPPLIES BY ULTRAFILTRATION ...1.0185

Rhizosphere

THE DISPOSITION OF PESTICIDES IN THE SOIL ...1.0030

Rhode Island

TRANSFER OF PESTICIDES THROUGH SOILS, WATER, SEDIMENTS AND AQUATIC LIFE ...1.0202

Rickettsia

FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...2.0053
AQUICULTURE, SALMON CULTURE - RESEARCH ...3.0053
EPIDEMOLOGY OF 'SALMON POISONING' DISEASE ...3.0054

Anaplasma

BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...2.0040
TRANSMISSION OF ANAPLASMOSIS ...4.0032
A STUDY IN INSECT TRANSMISSION OF ANAPLASMOSIS ...4.0064
MOSQUITOES AS VECTORS OF LIVESTOCK DISEASES ...4.0065

Riparian Land

CHEMICAL CONTROL OF DITCHBANK WEEDS IN PEAT AND SANDY SOIL AREAS OF SOUTH FLORIDA ...2.0114

River Basins

GREEN BAY RESEARCH PROGRAM ...1.0112
UPPER ST. JOHNS RIVER BASIN WATER QUALITY, FLORIDA ...1.0134
PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166
THE RELATIONSHIP BETWEEN THE USE OF AGRICULTURAL CHLORINATED HYDROCARBONS AND THEIR RESIDUES IN CHANNEL CATFISH ...1.0298
THE UPTAKE OF DIELDRIN IN THE THREE RIDGED NAIAD, AMBLEMA PLICATA ...1.0301

Rotations

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010
CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...1.0051
MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...1.0098
WEED CONTROL IN RICE PRODUCTION ...2.0097

Rotenone -see Pesticides

EVALUATION OF GIZZARD SHAD AS A FORAGE FISH ...1.0356
STRIPED BASS STUDIES ...2.0193
BIOLOGICAL AND LIMNOLOGICAL INVENTORY OF SEVEN FLOOD CONTROL RESERVOIRS IN THE STATE OF INDIANA ...2.0199
JO-MARY POND RECLAMATION ...2.0201
ESTABLISH MINIMUM DOSES OF ANTIMYCIN AND ROTENONE NEEDED FOR TOTAL KILLS OF TARGET FISHES ...2.0247
RENOVATION OF TROUT STREAMS ...4.0076
REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES ...4.0083

Runoff

EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...1.0100
EFFECT OF PESTICIDES ON THE QUALITY OF SURFACE AND GROUND WATERS IN THE WESTERN GULF REGION ...1.0101
IDENTIFICATION AND DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND RUNOFF AND DRAINAGE WATERS. ...1.0110

Agricultural Runoff

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029
PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...1.0033
EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041
ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS ...1.0049
CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...1.0051
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065
NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073
EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...1.0074
PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...1.0075
EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS ...1.0080
PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...1.0090
FATES OF AGRICULTURAL CHEMICALS IN SOILS ...1.0092
MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...1.0098
MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099
INTERFERING SOIL CONSTITUENTS IN DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND WATER ...1.0109
PREDICTING MINERAL QUALITY OF RETURN FLOW WATER ...1.0122
ATTENTION AND RUNOFF OF PESTICIDES FROM AGRICULTURAL LANDS TO SURFACE WATERS ...1.0124
RURAL RUNOFF CONTROL ...1.0135
LIMNOLOGICAL FACTORS AFFECTING PESTICIDE RESIDUES IN SURFACE WATERS ...1.0149
POLLUTION LOADS IN RUNOFF FROM SMALL AGRICULTURAL WATERSHEDS ...1.0154
PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...1.0170
LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION ...1.0178
GROUND AND SURFACE WATERS - POLLUTION ...1.0182
QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191
RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION ...1.0194
QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204
CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...1.0205
INVESTIGATION OF RICE IRRIGATION RETURN FLOWS - TEXAS COASTAL PRAIRIE REGION ...1.0209
OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...1.0219
CONTAMINATION OF CHANNEL CATFISH WITH DIELDRIN FROM AGRICULTURAL RUNOFF ...1.0247
PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...1.0358
THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...2.0150

Storm - Runoff Relationships

MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...1.0071
EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...1.0074
FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095
MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...1.0098
FERTILIZERS AND SEDIMENTS AS WATER POLLUTANTS ...1.0179
QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187
PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...1.0199
PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...1.0328

Subsurface Runoff

NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073
FATES OF AGRICULTURAL CHEMICALS IN SOILS ...1.0092

Urban Runoff

QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187
PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...1.0199

Rural Areas

REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...1.0047
RURAL RUNOFF CONTROL ...1.0135
TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE ...1.0201
ILLINOIS LAWS AFFECTING AGRICULTURE ...1.0332
RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070
CALIFORNIA ENCEPHALITIS VIRUS IN WISCONSIN ...4.0075

Safety Measures

Hazardous Materials

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086

Preventative Measures

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...1.0032
PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...1.0052
CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086
COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...1.0125

Safety Measures -other

PESTICIDE RESIDUES IN ENVIRONMENT AND EFFECTS ON MARKETING AGRICULTURAL COMMODITIES ...1.0062
DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...1.0184

Safety Measures -pesticides

METHODS FOR DISPOSAL OF SPILLED AND UNUSED PESTICIDES ...1.0060
CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086
CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0093
DEVELOP A SELECTIVE ALGACIDE TO CONTROL NUISANCE ALGAL GROWTH ...2.0151

Saline Soils

SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...1.0066
QUALITY OF IRRIGATION RETURN FLOW ...1.0102
STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...2.0159
ANATOMICAL, PHYSIOLOGICAL AND ECOLOGICAL STUDIES ON MYRIOPHYLLUM SPICATIU ...4.0013
OCCURRENCE AND BIONOMICS OF BLOODSUCKING MIDGES (DIPTERA: CERATOPOGONIDAE) IN IOWA ...4.0056

Sampling Methods

DEVELOPMENT OF FIELD METHODS IN SAMPLING WATER FOR PESTICIDE ANALYSIS ...1.0173
ARTIFICIAL SUBSTRATE SAMPLERS AS INDICATORS OF WATER QUALITY ...1.0225
PESTICIDE RESIDUES IN OR ON RAW AGRICULTURAL COMMODITIES ...1.0306

San Francisco Bay

ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120

Sanitation

CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266
RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070

Saponins

INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...2.0280

Scanning

PESTICIDE RESIDUES ON ARIZONA CROPS ...1.0007

Screening Potential Pesticides

EFFECTS OF PESTICIDES ON AQUATIC ANIMALS IN THE ESTUARINE AND MARINE ENVIRONMENTS ...1.0234
SCREENING OF PESTICIDES AGAINST FISH AT COLUMBIA MISSOURI ...1.0277
CONTROL OF COMMON HOUSEFLY ...2.0005
EVALUATION OF NEW INSECTICIDES ...2.0015
NEW INSECTICIDES & TECHNIQUES FOR PEST CONTROL ...2.0016
INVESTIGATIONS OF THE ACTION OF CHEMOSTERILANTS ON HOUSEFLIES AND OTHER MEDICALLY IMPORTANT ARTHROPODS ...2.0026
SYNTHETIC INSECT CONTROL AGENTS, GAINESVILLE ...2.0028
INSECT CHEMOSTERILANTS ...2.0049
BIOLOGICAL EVALUATION OF INSECT CONTROL AGENTS ...2.0050
STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS ...2.0067
SELECTIVE TOXICITY BY OPTICALLY ACTIVE PHOSPHONOTHIONATE PESTICIDES ...2.0086
CHEMICAL CONTROL OF WEEDS IN PONDS ...2.0093
WEED CONTROL IN CITRICULTURE ...2.0123
FACTORS CONTROLLING THE GROWTH OF THE AQUATIC WEED SALVINIA ...2.0166
INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...2.0167
WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...2.0176
BIOASSAY ...2.0211
INTENSIVE SCREENING OF POTENTIAL FISH CONTROL AGENTS - POTENTIATION OF ANTIMYCIN ...2.0241
BIOLOGY AND CONTROL OF SNAILS ...2.0268

BIOLOGY AND CONTROL OF TERRESTRIAL MOLLUSCS ...2.0281
CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER ...2.0290
OYSTER DRIL (OCINEBRA JAPONICA) CONTROL ...2.0293
THE CONTROL OF SLUGS ...2.0294
CHEMOTHERAPEUTIC STUDIES ON FISH PATHOGENIC BACTERIA ...3.0123
DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...4.0051
BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...4.0058

Sea Water Chemistry

ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120
A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...1.0158
ADSORPTION OF PESTICIDES FROM SEA WATER ...1.0159
RESEARCH VESSEL OPERATIONS ...3.0048

Sea Water Motion

RESEARCH VESSEL OPERATIONS ...3.0048

Sea Water Properties

Depth

ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120

Optical

RESEARCH VESSEL OPERATIONS ...3.0048

Temperature

ADSORPTION OF PESTICIDES FROM SEA WATER ...1.0159

Turbidity

ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120
RESEARCH VESSEL OPERATIONS ...3.0048

Sedimentology

WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...1.0005
MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...1.0098
EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...1.0100
GREEN BAY RESEARCH PROGRAM ...1.0112
ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191
QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0223

Composition

Chemical

ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120

Interstitial - Connate Water

RESEARCH VESSEL OPERATIONS ...3.0048

Mineralogical

ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120

Organic

ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120
THE FACTOR CONTROLLING THE DYNAMICS OF NONIONIC SYNTHETIC ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS ...1.0148

Organic Deposits

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029

Physical Properties

Adsorption Capacity

POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...1.0036
GREEN BAY RESEARCH PROGRAM ...1.0112
THE FACTOR CONTROLLING THE DYNAMICS OF NONIONIC SYNTHETIC ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS ...1.0148
SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...1.0181
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0223
INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...4.0027

Permeability

EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...1.0100

Size

ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211

Suspension

ORGANIC GEOCHEMISTRY OF SAN FRANCISCO BAY WATERS AND SEDIMENTS ...1.0120
THE FACTOR CONTROLLING THE DYNAMICS OF NONIONIC SYNTHETIC ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS ...1.0148
ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211
INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...4.0027

Seeds -see Plant Morphology

LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010

Seepage

EFFECT OF PESTICIDES ON THE QUALITY OF SURFACE AND GROUND WATERS IN THE WESTERN GULF REGION ...1.0101

Selectivity of Pest Control

METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186

Selenium

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174

Separation

DEVELOPMENT OF FIELD METHODS IN SAMPLING WATER FOR PESTICIDE ANALYSIS ...1.0173

Coagulation

PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...1.0094

Filtration

SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL ...1.0012

CONCENTRATION AND ANALYSIS OF PESTICIDES AND OTHER RECALCITRANT MOLECULES IN WATER SUPPLIES BY ULTRAFILTRATION ...1.0185

ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211

Flocculation

PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...1.0094

Gel Filtration

DEVELOPMENT OF FIELD METHODS IN SAMPLING WATER FOR PESTICIDE ANALYSIS ...1.0173

Sewage

STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES ...1.0142

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183

PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...1.0199

BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES ...2.0014

INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...4.0001

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...4.0018

Sheep & Goat Husbandry

INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...2.0280

Silicates - Tectosilicates

ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106

Skin Conditions

CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266

SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...2.0278

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045

(U) REPELLENCY AND ATTRACTIVENESS OF MAN TO MOSQUITO BITES ...4.0040

ATTRACTIVENESS AND REPELLENCY OF MAN TO MOSQUITO BITES ...4.0041

Snowmelt

FATES OF AGRICULTURAL CHEMICALS IN SOILS ...1.0092

Social Sciences

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161

WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...1.0162

INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...4.0059

Attitudes & Attitude Change

INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...4.0059

Citizen's Participation

LEGAL REPRESENTATION OF CITIZEN'S INTERESTS IN ENVIRONMENTAL PROTECTION ...2.0069

Ecology

LEGAL REPRESENTATION OF CITIZEN'S INTERESTS IN ENVIRONMENTAL PROTECTION ...2.0069

Law and Legal Procedures

ILLINOIS LAWS AFFECTING AGRICULTURE ...1.0332

LEGAL REPRESENTATION OF CITIZEN'S INTERESTS IN ENVIRONMENTAL PROTECTION ...2.0069

Legislative Processes

ILLINOIS LAWS AFFECTING AGRICULTURE ...1.0332

Science

LEGAL REPRESENTATION OF CITIZEN'S INTERESTS IN ENVIRONMENTAL PROTECTION ...2.0069

Soil Analysis

Core Samples

SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072

Soil Profile Studies

CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...1.0051

Soil Testing

AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...1.0186

Soils, Column Leaching Diff

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013

MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS ...1.0028

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039

INACTIVATION AND LOSS PESTICIDES FROM SOIL ...1.0048

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0091

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0097

SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...1.0181

Soil Chemical Properties

CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS ...1.0042

QUALITY OF IRRIGATION RETURN FLOW ...1.0102

Absorption, Fixation, Exchange

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0002

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0006

SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL ...1.0012

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019
REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...1.0021
CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...1.0024
MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS ...1.0028
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034
BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053
TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...1.0056
RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...1.0057
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0084
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0085
PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...1.0090
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0097
MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105
RURAL RUNOFF CONTROL ...1.0135
THE FACTOR CONTROLLING THE DYNAMICS OF NONIONIC SYNTHETIC ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS ...1.0148
SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...1.0181
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0223
INSECTICIDE ADSORPTION BY LAKE SEDIMENTS AS A FACTOR CONTROLLING INSECTICIDE ACCUMULATION IN LAKES ...1.0224
CHLORINATED ORGANIC CONTAMINANTS IN THE MILWAUKEE RIVER ...1.0226
WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...2.0104
BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162

Chemical Properties -other

REACTIONS OF PESTICIDES WITH SOILS ...1.0020
REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...1.0021
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061
MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...1.0071
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081

Mineralogy

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008
REACTIONS OF PESTICIDES WITH SOILS ...1.0020
HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...1.0035
CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS ...1.0042
SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072
NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076

PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...1.0090

Movement, Availability

CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...1.0024
EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041
INACTIVATION AND LOSS PESTICIDES FROM SOIL ...1.0048
SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072
NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073
EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS ...1.0080
FATES OF AGRICULTURAL CHEMICALS IN SOILS ...1.0092
INTERFERING SOIL CONSTITUENTS IN DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND WATER ...1.0109
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0192
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0334
STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...2.0159

Soil Analysis

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013
RESPROUTING OF CHAPARRAL ...1.0017
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023
DISPOSITION OF PESTICIDES IN THE SOIL ...1.0031
EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...1.0074

Soil Contamination

EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041
REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0046
RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...1.0057
PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS ...1.0063
THE CYCLING OF CL-36 LABELED DDT IN NATURAL ECOSYSTEMS ...1.0078
DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...1.0196
TRANSFER OF PESTICIDES THROUGH SOILS, WATER, SEDIMENTS AND AQUATIC LIFE ...1.0202
ENVIRONMENTAL TOXICOLOGY OF PESTICIDES ...1.0361

Soil Density

SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072

Soil Depth

DISPOSITION OF PESTICIDES IN THE SOIL ...1.0031
EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...1.0074

Soil Ecology

THE DISPOSITION OF PESTICIDES IN THE SOIL ...1.0030

EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...**1.0041**

INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0043**

PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS ...**1.0055**

EFFECTS OF INSECTICIDES ON ACTIVITY OF SOIL INHABITING INSECTS ...**1.0059**

INTERACTION OF HERBICIDES AND SOIL MICROORGANISMS ...**1.0069**

BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...**1.0083**

PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...**1.0087**

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...**1.0334**

IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS ...**1.0335**

BIOLOGICAL STUDIES OF CULICOIDES AND THEIR CONTROL IN THE CANAL ZONE ...**4.0043**

Soil Environment -pesticide

INTERFERING SOIL CONSTITUENTS IN DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND WATER ...**1.0109**

PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...**1.0163**

Chemical Degradation

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...**1.0008**

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...**1.0010**

REACTIONS OF PESTICIDES WITH SOILS ...**1.0020**

REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...**1.0021**

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0023**

CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...**1.0024**

CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS ...**1.0042**

FATE OF PESTICIDES ...**1.0064**

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0076**

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0084**

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...**1.0091**

SOILS, PESTICIDES AND THE QUALITY OF WATER ...**1.0105**

SOILS, PESTICIDES AND THE QUALITY OF WATER ...**1.0141**

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...**1.0228**

Microbial Degradation

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0002**

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0023**

THE DISPOSITION OF PESTICIDES IN THE SOIL ...**1.0030**

HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...**1.0035**

EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...**1.0041**

INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...**1.0043**

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...**1.0053**

INTERACTION OF HERBICIDES AND SOIL MICROORGANISMS ...**1.0069**

MULTI-DISCIPLINARY RESEARCH IN POLLUTION ...**1.0070**

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...**1.0081**

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...**1.0082**

PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...**1.0087**

CONSTRUCTION OF PESTICIDES DEGRADABLE BY NORMAL MICROFLORA OF NATURAL WATERS AND SOILS ...**1.0331**

ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...**2.0089**

Movement, Leaching

LEACHING OF SELECTED HERBICIDES IN ALABAMA SOILS ...**1.0001**

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0002**

CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...**1.0004**

WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...**1.0005**

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0006**

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...**1.0008**

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0009**

MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS ...**1.0011**

SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL ...**1.0012**

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0013**

VOLATILIZATION LOSSES OF PESTICIDES FROM SOILS ...**1.0016**

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...**1.0019**

REACTIONS OF PESTICIDES WITH SOILS ...**1.0020**

REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...**1.0021**

BEHAVIOR OF POLLUTANTS IN WATER ...**1.0022**

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0023**

CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...**1.0024**

MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS ...**1.0028**

THE DISPOSITION OF PESTICIDES IN THE SOIL ...**1.0030**

DISPOSITION OF PESTICIDES IN THE SOIL ...**1.0031**

PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...**1.0033**

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0034**

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...**1.0039**

EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...**1.0041**

MOVEMENT OF HERBICIDES IN SOIL BY MASS FLOW ...**1.0044**

WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...**1.0050**

CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...**1.0051**

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...**1.0053**

CONTROL OF PESTICIDES IN SOIL AND WATER ...**1.0054**

PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS ...**1.0055**

RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...**1.0057**

EFFECTS OF INSECTICIDES ON ACTIVITY OF SOIL INHABITING INSECTS ...**1.0059**

SOILS, PESTICIDES AND THE QUALITY OF WATER ...**1.0061**

SOILS, PESTICIDES AND THE QUALITY OF WATER ...**1.0065**

SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...**1.0066**

MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...**1.0071**

SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...**1.0072**

NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073
EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...1.0074
PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...1.0075
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076
FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL ...1.0077
EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS ...1.0080
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081
BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0084
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0085
PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...1.0090
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0091
FATES OF AGRICULTURAL CHEMICALS IN SOILS ...1.0092
FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095
PERSISTENCE AND MODES OF HERBICIDE DISSIPATION UNDER RANGELAND CONDITIONS ...1.0096
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0097
MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...1.0098
MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099
SOILS, PESTICIDES, AND THE QUALITY OF WATER ...1.0103
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105
ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106
FATE OF INSECTICIDES IN SOIL AND THEIR MOVEMENT IN WATER AND CROPS ...1.0111
RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS ...1.0138
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0141
SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...1.0181
CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...1.0189
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191
TRANSFER OF PESTICIDES THROUGH SOILS, WATER, SEDIMENTS AND AQUATIC LIFE ...1.0202
OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...1.0219
ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0334
ECOLOGY OF PESTICIDES IN AN AQUATIC ECOSYSTEM ...1.0339
INSECTICIDES AND EGG-SHELL DEPOSITION ...1.0368

Persistance-residues in Soils

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0002
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0006
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0009
EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010
MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS ...1.0011
SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL ...1.0012
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013
RESPROUTING OF CHAPARRAL ...1.0017
ANALYTICAL METHODS FOR PESTICIDES IN SOIL AND WATER ...1.0018
RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019
REACTIONS OF PESTICIDES WITH SOILS ...1.0020
REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...1.0021
BEHAVIOR OF POLLUTANTS IN WATER ...1.0022
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023
CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...1.0024
CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025
THE DISPOSITION OF PESTICIDES IN THE SOIL ...1.0030
DISPOSITION OF PESTICIDES IN THE SOIL ...1.0031
PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...1.0033
HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...1.0035
REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0037
PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039
REDUCTION OF PESTICIDE RESIDUE HAZARDS ...1.0040
EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041
CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS ...1.0042
INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0043
REDUCTION OF RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0046
REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...1.0047
INACTIVATION AND LOSS PESTICIDES FROM SOIL ...1.0048
WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...1.0050
CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...1.0051
BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053
CONTROL OF PESTICIDES IN SOIL AND WATER ...1.0054
PERSISTENCE, ACCUMULATION AND FATE OF PESTICIDES IN CRANBERRY SOILS AND RESERVOIRS ...1.0055
TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...1.0056
EFFECTS OF INSECTICIDES ON ACTIVITY OF SOIL INHABITING INSECTS ...1.0059
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061
AN EVALUATION OF THE INSECTICIDE 'SEVIN' AS A WATERSHED POLLUTANT ...1.0067
MULTI-DISCIPLINARY RESEARCH IN POLLUTION ...1.0070
MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...1.0071
PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...1.0075
FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL ...1.0077
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081
MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082
BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083
FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...1.0089
PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...1.0090
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0091
PERSISTENCE AND MODES OF HERBICIDE DISSIPATION UNDER RANGELAND CONDITIONS ...1.0096
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0097

MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...1.0098

MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099

ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106

IDENTIFICATION AND DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND RUNOFF AND DRAINAGE WATERS. ...1.0110

FATE OF INSECTICIDES IN SOIL AND THEIR MOVEMENT IN WATER AND CROPS ...1.0111

UPTAKE AND RELEASE OF DALAPON IN EARTHEN PONDS ...1.0114

ATTENTION AND RUNOFF OF PESTICIDES FROM AGRICULTURAL LANDS TO SURFACE WATERS ...1.0124

COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...1.0125

RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS ...1.0138

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0141

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...1.0143

SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...1.0181

CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...1.0189

PESTICIDES MOVEMENT FROM CROPLAND INTO LAKE ERIE ...1.0193

PESTICIDE CONTAMINATION OF ENVIRONMENT ...1.0250

PESTICIDES AND WILDLIFE ...1.0324

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...1.0328

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0334

IMPACT OF PESTICIDES UPON SEMI-WILD ECOSYSTEMS ...1.0335

EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS ...1.0341

TOXICOLOGY OF PESTICIDES IN THE ENVIRONMENT ...1.0360

THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...1.0365

WEED CONTROL IN RICE PRODUCTION ...2.0097

WEED CONTROL IN RICE PRODUCTION ...2.0098

AQUATIC PLANT CONTROL ...2.0128

WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...2.0179

CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187

Soil Degradation -other

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0006

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019

REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...1.0021

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023

PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...1.0033

RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...1.0057

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061

FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...1.0089

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0097

ATTENTION AND RUNOFF OF PESTICIDES FROM AGRICULTURAL LANDS TO SURFACE WATERS ...1.0124

DEVELOP EFFECTIVE TREATMENT METHODS FOR HARD PESTIDICIDES ...1.0136

DEVELOP EFFECTIVE TREATMENT METHODS FOR HARD PESTICIDES ...1.0197

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319

PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105

Soil Microbiology

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023

THE DISPOSITION OF PESTICIDES IN THE SOIL ...1.0030

RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...1.0057

MULTI-DISCIPLINARY RESEARCH IN POLLUTION ...1.0070

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...1.0082

BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083

PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...1.0087

Soil Minerals -natural

NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0027

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029

Soil Moisture

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0006

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0009

MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS ...1.0011

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019

REACTIONS OF PESTICIDES WITH SOILS ...1.0020

REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...1.0021

BEHAVIOR OF POLLUTANTS IN WATER ...1.0022

NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0027

MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS ...1.0028

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029

THE DISPOSITION OF PESTICIDES IN THE SOIL ...1.0030

PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...1.0033

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034

HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...1.0035

POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...1.0036

MOVEMENT OF HERBICIDES IN SOIL BY MASS FLOW ...1.0044

INACTIVATION AND LOSS PESTICIDES FROM SOIL ...1.0048

WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...1.0050

CONTROL OF PESTICIDES IN SOIL AND WATER ...1.0054

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065

SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...1.0066

SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072

NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073

PESTICIDE RESIDUES IN PLANTS, ANIMALS, SOILS, AND WATER ...1.0075
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081
BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083
FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095
MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099
QUALITY OF IRRIGATION RETURN FLOW ...1.0102
IDENTIFICATION AND DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND RUNOFF AND DRAINAGE WATERS. ...1.0110
FATE OF INSECTICIDES IN SOIL AND THEIR MOVEMENT IN WATER AND CROPS ...1.0111
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0141
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0192
AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...4.0011

Excessive Moisture

OCCURRENCE AND BIONOMICS OF BLOODSUCKING MIDGES (DIPTERA: CERATOPOGONIDAE) IN IOWA ...4.0056

Infiltration

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105

Moisture Deficiency

THE DISPOSITION OF PESTICIDES IN THE SOIL ...1.0030
EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082

Soil Moisture -general

FOREST AND FARM GAME HABITAT; FISH POND ...2.0143
THE CONTROL OF SLUGS ...2.0294

Tension and Measurement

BEHAVIOR OF POLLUTANTS IN WATER ...1.0022
EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041
MOVEMENT OF HERBICIDES IN SOIL BY MASS FLOW ...1.0044
MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...1.0071
SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072

Water Table - Depth of

SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072

Soil Morphology, Profiles

EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041
EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS ...1.0080

Soil Nutrients

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029
EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041
PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...1.0199
WATERLEVEL MANAGEMENT ON IMPOUNDMENTS OF LOW QUALITY SOILS ...2.0163

Aluminum

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0084

Barium

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076

Calcium - Other Than Lime

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076
STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...2.0159

Cesium

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076

Chlorine

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008

Copper

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0084

Iron

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0084

Lime

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008

Magnesium

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076

Nitrogen

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008
ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS ...1.0049
NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073
BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083
EVALUATION AND DEMONSTRATION OF IRRIGATION METHODS AND PRACTICES TO REDUCE CONTAMINATION IN IRRIGATION WASTE WATER ...1.0104
LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION ...1.0178
FERTILIZERS AND SEDIMENTS AS WATER POLLUTANTS ...1.0179
AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...1.0186
RELATIVE LEACHING RATES OF COMMON NITROGEN CARRIERS FROM SANDY SOILS IN RELATION TO LAKE EUTROPHICATION ...4.0006

Oxygen

CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...1.0024

Phosphorus

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0002

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008
NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0027
SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072
NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073
LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION ...1.0178
FERTILIZERS AND SEDIMENTS AS WATER POLLUTANTS ...1.0179
AGRICULTURAL CONTRIBUTIONS TO NUTRIENTS IN WATER ...1.0186
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0192

Potassium
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076

Sodium
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076

Sulfur
INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008
ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS ...1.0049

Soil pH

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010
CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS ...1.0042
INACTIVATION AND LOSS PESTICIDES FROM SOIL ...1.0048
BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061
INTERACTION OF HERBICIDES AND SOIL MICROORGANISMS ...1.0069
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0084
FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105
SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...1.0181
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191

Soil Physical Properties

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023
CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS ...1.0042
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061
SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072
NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...1.0073

Soil Structure

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019
REACTIONS OF PESTICIDES WITH SOILS ...1.0020
HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...1.0035
MOVEMENT OF HERBICIDES IN SOIL BY MASS FLOW ...1.0044
EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...1.0074
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105

Air - Water - Plant Relations
VOLATILIZATION LOSSES OF PESTICIDES FROM SOILS ...1.0016

Management Effects
PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...1.0033
SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072

Soil Texture

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0084
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191

Soil Tillage

NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0027
NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029
SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072
LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION ...1.0178
FERTILIZERS AND SEDIMENTS AS WATER POLLUTANTS ...1.0179
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0192
PESTICIDES MOVEMENT FROM CROPLAND INTO LAKE ERIE ...1.0193
QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204

Chemical Tillage or Nontillage
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...1.0196

Cultivating
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145

Minimum Tillage
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0192

Soil Tillage Methods -other
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191

Soil Types

LEACHING OF SELECTED HERBICIDES IN ALABAMA SOILS ...1.0001
SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL ...1.0012

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013
RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019
HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...1.0035
MOVEMENT OF HERBICIDES IN SOIL BY MASS FLOW ...1.0044
INACTIVATION AND LOSS PESTICIDES FROM SOIL ...1.0048
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061
AN EVALUATION OF THE INSECTICIDE 'SEVIN' AS A WATERSHED POLLUTANT ...1.0067
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081
FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095
MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099
INTERFERING SOIL CONSTITUENTS IN DETERMINATION OF PESTICIDE RESIDUES IN SOIL AND WATER ...1.0109
LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION ...1.0178
EFFECT OF ENDRIN ON FISH AND THEIR ENVIRONMENT UNDER CONTROLLED CONDITIONS ...1.0230

Clay

CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...1.0004
EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010
HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...1.0035
CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS ...1.0042
INACTIVATION AND LOSS PESTICIDES FROM SOIL ...1.0048
WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...1.0050
CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...1.0051
BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0061
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065
INTERACTION OF HERBICIDES AND SOIL MICROORGANISMS ...1.0069
SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...1.0072
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0076
PHYSICAL-CHEMICAL ASPECTS OF PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL ...1.0090
MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...1.0098
SOILS, PESTICIDES, AND THE QUALITY OF WATER ...1.0103
ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106
RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS ...1.0138
SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...1.0181

High Organic Soils

NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0027
NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029
TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...1.0056

Loam

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0009
REACTIONS OF PESTICIDES WITH SOILS ...1.0020
CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...1.0051
FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...1.0089
RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION ...1.0194

Organic Soils -nonspecific

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0009
PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...1.0033
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081

Sand

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029
CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...1.0051
MOVEMENT OF HERBICIDES IN SOIL, SURFACE WATER AND UNDERGROUND WATER ...1.0099
SOILS, PESTICIDES, AND THE QUALITY OF WATER ...1.0103
RELATIONSHIPS BETWEEN PESTICIDES AND GEORGIA FARM POND ECOSYSTEMS ...1.0138
RELATIVE LEACHING RATES OF COMMON NITROGEN CARRIERS FROM SANDY SOILS IN RELATION TO LAKE EUTROPHICATION ...4.0006

Saturated - Unsaturated Soils

MOVEMENT OF HERBICIDES IN SOIL BY MASS FLOW ...1.0044
SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...1.0066

Silt

REACTIONS OF PESTICIDES WITH SOILS ...1.0020
CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...1.0051
FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...1.0089
RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION ...1.0194

Soil-water-plant Relationships

SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL ...1.0012

Solid Waste

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086

South America

FACTORS CONTROLLING THE GROWTH OF THE AQUATIC WEED SALVINIA ...2.0166
METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186

South Dakota

EFFECTS OF A SNAPPING TURTLE POPULATION ON THE WATERFOWL PRODUCTIVITY OF A MARSH ...2.0292

Southeast Asia

LABORATORY ANALYSIS OF INSECTICIDE EFFECTIVENESS AGAINST MEDICALLY IMPORTANT INSECTS ...4.0068

Space Requirements

THE INFLUENCES OF ENVIRONMENTAL CONDITIONS ON THE TOXICITY OF PESTICIDES ...1.0278

FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...2.0053

MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...2.0124

Space, Extraterrestrial

ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...4.0007

Spectral Techniques

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...1.0319

Atomic Absorption

ATOMIC ABSORPTION ANALYSIS OF PHOSPHATES IN WATER ...1.0227

Infra Red

CHARACTERIZATION OF SURFACES OF CRYSTALLINE AND AMORPHOUS SOIL COLLOIDS ...1.0042

Mass Spectroscopy

DEVELOPMENT OF TECHNIQUES FOR IDENTIFICATION OF PESTICIDES AND THEIR METABOLITES BY MASS SPECTROMETRY ...1.0295

Nuclear Magnetic Resonance

ATOMIC ABSORPTION ANALYSIS OF PHOSPHATES IN WATER ...1.0227

Spirochetes

Leptospira

EPIZOOTIOLOGY OF LEPTOSPIRES - FISH SUSCEPTIBILITY TO L. ICTEROHAEMORRHIGICA (ABBREV) ...3.0023

Standards

TRACE LEVELS OF PESTICIDE RESIDUES IN AGRICULTURAL COMMODITIES IN MARKETING CHANNELS ...1.0344

Sterigmatocystin

MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...3.0056

Sterilization -chemical

Disinfectants

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

Fish Sterilants

STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES ...2.0256

Invertebrate Sterilants

CONTROL OF CULEX NIGRIPALPUS BY STERILITY METHODS ...2.0032

MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085

Soil Sterilants

CHEMICAL CONTROL OF DITCHBANK WEEDS IN PEAT AND SANDY SOIL AREAS OF SOUTH FLORIDA ...2.0114

Sterilants

INSECT CHEMOSTERILANTS ...2.0049

Storage of Chemicals

LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...1.0212

PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...2.0105

Storm Water

STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES ...1.0142

QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187

PROVIDE A CONTINUOUS SURVEY OF THE LITERATURE ON STORM AND COMBINED SEWERS ...1.0199

RELATIVE LEACHING RATES OF COMMON NITROGEN CARRIERS FROM SANDY SOILS IN RELATION TO LAKE EUTROPHICATION ...4.0006

Stratification -water

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168

EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...2.0171

NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180

Stratigraphy

PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...1.0094

Streams

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039

BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053

GREEN BAY RESEARCH PROGRAM ...1.0112

EFFLUENT INFLUENCES OF THE MISSISSIPPI RIVER ON THE CHEMISTRY AND BIOLOGY OF ADJACENT OCEAN SYSTEMS ...1.0130

EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133

UPPER ST. JOHNS RIVER BASIN WATER QUALITY, FLORIDA ...1.0134

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN ...1.0143

RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146

LIMNOLOGICAL FACTORS AFFECTING PESTICIDE RESIDUES IN SURFACE WATERS ...1.0149

PESTICIDE RESIDUES IN KANSAS STREAMS ...1.0150

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161

PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0164

PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166

PRESTICIDE INPUTS AND LEVELS IN MINNESOTA WATERS OF THE LAKE SUPERIOR BASIN ...1.0167

LOSSES OF FERTILIZERS AND PESTICIDES IN RUNOFF EROSION ...1.0178

GROUND AND SURFACE WATERS - POLLUTION ...1.0182

PESTICIDES MOVEMENT FROM CROPLAND INTO LAKE ERIE ...1.0193

TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE ...1.0201

SOURCES OF QUALITY IMPAIRMENT OF SURFACE WATERS ...1.0218

MICROBIOLOGY OF FARM PONDS ...1.0220

TERMINAL RESIDUES OF CHLORINATED HYDROCARBON PESTICIDES IN LAKE MICHIGAN AND ASSOCIATED TRIBUTARIES ...**1.0222**
ARTIFICIAL SUBSTRATE SAMPLERS AS INDICATORS OF WATER QUALITY ...**1.0225**
CHLORINATED ORGANIC CONTAMINANTS IN THE MILWAUKEE RIVER ...**1.0226**
THE OCCURRENCE OF PESTICIDE RESIDUES IN THE LOWER BRISBANE RIVER AND IN THE TISSUES OF ESTUARINE ANIMALS ...**1.0233**
CONTAMINATION OF CHANNEL CATFISH WITH DIELDRIN FROM AGRICULTURAL RUNOFF ...**1.0247**
ENZYME AND TISSUE ALTERATIONS IN FISH - A MEASURE OF WATER QUALITY ...**1.0248**
THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...**1.0253**
PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES ...**1.0254**
FIELD STUDIES OF PESTICIDE EFFECTS ON FISHES ...**1.0257**
THE EFFECT OF DIELDRIN ON SURVIVAL AND DEVELOPMENT OF FISH EGGS ...**1.0300**
EFFECTS OF TOXICANTS UPON FISH MOVEMENT PATTERNS ...**1.0308**
PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...**1.0328**
BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...**1.0342**
SELECTED PESTICIDES IN AQUATIC FUNGI IN THE THREE RIVERS AREA ...**1.0345**
PREVENTION OF PESTICIDE POLLUTION FROM COASTAL INSECT CONTROL PROGRAMS ...**1.0358**
BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS ...**2.0054**
SURVEY OF INSECT PROBLEMS IN MONTANA ...**2.0059**
DISTRIBUTION AND ECOLOGY OF PENNSYLVANIA SALAMANDERS ...**2.0080**
INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...**2.0144**
THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...**2.0150**
SOUAWFISH STUDIES--ST. JOE RIVER, IDAHO ...**2.0196**
SEA LAMPREY CONTROL - LAKE MICHIGAN CHEMICAL CONTROL ...**2.0203**
SEA LAMPREY CONTROL - LAKE HURON CHEMICAL CONTROL ...**2.0204**
LAKE SUPERIOR CHEMICAL CONTROL OF SEA LAMPREY ...**2.0205**
SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...**2.0206**
SEA LAMPREY CONTROL - ASSESSMENT METHODS ...**2.0208**
LAKE HURON CHEMICAL CONTROL ...**2.0209**
BIOASSAY ...**2.0211**
EXPERIMENTAL RESTORATION OF THE GILA TROUT ...**2.0218**
TRIBUTARY SURVEY OF LAKES ONTARIO AND ERIE ...**2.0220**
PLANNING FOR CREATION OF SALMONID FISHERIES IN LAKE ONTARIO ...**2.0221**
PRE-LAMPREY CONTROL INVENTORY OF FISH STOCKS ...**2.0222**
DEVELOPMENT OF ACCURATE CHEMICAL INTRODUCTION TECHNIQUES ...**2.0223**
TIME-CONCENTRATION TESTS INVOLVING NEUTRALIZATION OF ROTENONE WITH POTASSIUM PERMANGANATE ...**2.0224**
NEUTRALIZATION OF ROTENONE WITH ACTIVATED CHARCOAL ...**2.0225**
DEVELOPMENT OF RHODAMINE-B DYE TO TRACE FLOW AND DISPERSION PATTERNS IN STREAMS AS AN ADJUNCT TO TREATING STREAMS WITH FISH-CONTROL CHEMICALS ...**2.0245**
THE EFFICACY OF NEW FORMULATIONS OF ANTIMYCIN IN NATURAL LAKES AND STREAMS ...**2.0246**
EXPERIMENTAL RECLAMATION OF TROUT STREAMS THROUGH CHEMICAL TREATMENT ...**2.0263**
BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...**2.0269**
SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...**2.0278**
DISEASES OF FISH ...**3.0025**
INVENTORY OF WATERS OF THE PROJECT AREA ...**3.0039**
PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...**3.0047**
INFECTIOUS DISEASES OF SALMONID FISHES ...**3.0049**
BIOLOGY OF THE PROTOZOAN PARASITE CERATOMYXA SHASTA ...**3.0050**
THE RELATIONSHIP OF TEMPERATURE TO DISEASE OF SALMONID FISHES ...**3.0051**
IMPACT OF CERATOMYXA IN CENTRAL OREGON SALMONID POPULATIONS ...**3.0057**
EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...**3.0083**
RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY ...**4.0002**
THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER ...**4.0004**
TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...**4.0005**
EUTROPHICATION OF IOWA LAKES AND STREAMS ...**4.0008**
OCCURRENCE OF FILAMENTOUS SLIMES ORGANISMS BELOW OUTFALLS ...**4.0009**
BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...**4.0012**
NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...**4.0015**
TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ...**4.0030**
INTER-DISCIPLINARY RESEARCH IN THE AREA OF THE KANO PLAINS, WESTERN KENYA ...**4.0059**
ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...**4.0069**
RENOVATION OF TROUT STREAMS ...**4.0076**
LIFE HISTORY OF ST. JOE RIVER CUTTHROAT TROUT ...**4.0077**

Sub-surface Drainage

PROPERTIES OF TILE DRAINAGE WATER ...**1.0045**

Sulfadimethoxine

CHEMOTHERAPY OF FISH DISEASES ...**3.0127**

Sulfonamides

EFFICACY OF A POTENTIATED SULFONAMIDE AGAINST FURUNCULOSIS INFECTIONS IN JUVENILE RAINBOW TROUT AND COHO SALMON ...**3.0125**

Sulfur

MODE OF ACTION, TOXICITY, AND FACTORS INFLUENCING THE EFFECTIVENESS OF FUNGICIDES ...**1.0082**

Sulfates

PROPERTIES OF TILE DRAINAGE WATER ...**1.0045**
ATOMIC ABSORPTION ANALYSIS OF PHOSPHATES IN WATER ...**1.0227**

Sulfides

INSECT CHEMOSTERILANTS ...**2.0049**

Sulfonates

INSECT CHEMOSTERILANTS ...**2.0049**

Sulfones

CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER ...**2.0290**

Surface Active Compounds

- PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0085
- DETECTION AND IDENTIFICATION OF MOLECULAR WATER POLLUTANTS BY LASER RAMAN SPECTROSCOPY ...1.0151
- THE BIOASSAY OF WATER POLLUTANTS WITH CULTURED MAMMALIAN CELLS ...1.0200
- BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342

Detergent

- MOVEMENT AND ADSORPTION OF PESTICIDES IN STERILIZED SOIL COLUMNS ...1.0028
- DETECTION AND IDENTIFICATION OF MOLECULAR WATER POLLUTANTS BY LASER RAMAN SPECTROSCOPY ...1.0151
- THE BIOASSAY OF WATER POLLUTANTS WITH CULTURED MAMMALIAN CELLS ...1.0200
- PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...1.0236
- ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...1.0326
- DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...1.0333

Surface Water

- BEHAVIOR OF POLLUTANTS IN WATER ...1.0022
- NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029
- EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANOTOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...1.0041
- WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...1.0050
- SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065
- MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...1.0071
- EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS ...1.0080
- SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105
- ATTENTION AND RUNOFF OF PESTICIDES FROM AGRICULTURAL LANDS TO SURFACE WATERS ...1.0124
- LIMNOLOGICAL FACTORS AFFECTING PESTICIDE RESIDUES IN SURFACE WATERS ...1.0149
- WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...1.0162
- CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...1.0189
- INVESTIGATION OF RICE IRRIGATION RETURN FLOWS - TEXAS COASTAL PRAIRIE REGION ...1.0209
- IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...2.0181

Swamps - Marshes

- TRANSLOCATION OF PESTICIDES FROM CRANBERRY BOGS TO THEIR SURROUNDINGS ...1.0056
- ADSORPTION OF PESTICIDES FROM SEA WATER ...1.0159
- THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...1.0253
- SELECTED PESTICIDES VS. WILDLIFE IN AQUATIC ENVIRONMENTS ...1.0325
- THE IMPORTANCE OF THE FOOD CHAIN IN BOTULISM INTOXICATION AMONG WATERFOWL LAKES AND SLOUGHS OF THE DEVILS LAKE REGION IN NORTH DAKOTA ...1.0359
- TESTING ADULT ATTRACTION DEVICES AND CHEMOSTERILANTS FOR TABANID FLY CONTROL ...2.0024
- INSECTICIDE AND NON-CHEMICAL CONTROL OF MOSQUITOES ...2.0025
- BIOLOGY AND ECOLOGY OF SALT-MARSH MOSQUITOES OF LOUISIANA ...2.0042
- BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043
- BIOLOGY AND WATER MANAGEMENT STUDIES FOR CONTROL OF LOUISIANA MOSQUITOES (RICE FIELDS) ...2.0044
- EFFECT OF PREDATORS AND PARASITES ON MOSQUITO BREEDING IN LOUISIANA ...2.0045
- COORDINATION OF MOSQUITO CONTROL IN NEW JERSEY ...2.0061
- MOSQUITO CONTROL - TIDAL MARSHES ...2.0063
- WATER MANAGEMENT IN MOSQUITO IMPOUNDMENTS ...2.0064
- MOSQUITO CONTROL IN UPLAND SWAMPS ...2.0065
- CONTROLLING MOSQUITOES ON HAYING MEADOWS ...2.0066
- EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA, PHASE 1 ...2.0073
- EFFECTS OF MOSQUITO CONTROL DITCHING ON HIGH SALT MARSHES IN NORTH CAROLINA ...2.0075
- EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082
- EVALUATION OF MANAGEMENT PRACTICES ON THE STATE-OWNED WILDLIFE AREAS ...2.0103
- EFFECTS OF WATER EXCHANGE AND BLUE CRAB CONTROL ON SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IMPOUNDMENTS ...2.0275
- EFFECTS OF A SNAPPING TURTLE POPULATION ON THE WATERFOWL PRODUCTIVITY OF A MARSH ...2.0292
- VIBRIO PARAHAEMOLYTICUS IN CHESAPEAKE BAY - ISOLATION, INCIDENCE AND PATHOGENICITY ...3.0026
- UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029

Sweat

- CHEMICAL IDENTIFICATION OF BIOLOGICALLY IMPORTANT NATURAL PRODUCTS ...2.0265
- (U) REPELLENCY AND ATTRACTIVENESS OF MAN TO MOSQUITO BITES ...4.0040
- ATTRACTIVENESS AND REPELLENCY OF MAN TO MOSQUITO BITES ...4.0041

Synergism and Synergists

- DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...1.0196
- EFFECTS OF PARATHION AND MALATHION ON WARM-WATER FISH PONDS ...1.0283
- CONTINUOUS-FLOW BIOASSAY OF PESTICIDES TO EVALUATE THE ACUTE AND CHRONIC EFFECTS OF PESTICIDES TO FRESHWATER INVERTEBRATES ...1.0294
- BIODEGRADATION OF PESTICIDES IN A FRESHWATER ECOSYSTEM - INTERACTION BETWEEN MICROORGANISMS AND PESTICIDES ...1.0352
- STUDIES ON INSECTICIDE RESISTANCE IN MOSQUITOES ...2.0017
- STRUCTURE-ACTIVITY RELATIONSHIPS AND MODE OF ACTION OF INSECTICIDE SYNERGISTS ...2.0067
- WEED CONTROL IN RICE PRODUCTION ...2.0098
- EXPANDED AQUATIC PLANT CONTROL PROJECT ...2.0146
- CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187
- INTENSIVE SCREENING OF POTENTIAL FISH CONTROL AGENTS - POTENTIATION OF ANTIMYCIN ...2.0241

Synthesis

Inorganic Synthesis

- INSECT CHEMOSTERILANTS ...2.0049

Organic Synthesis

- DEVELOPMENT OF ANALYTICAL METHODS FOR SELECTED HERBICIDES ...1.0175
- INSECT CHEMOSTERILANTS ...2.0049

CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER ...2.0290

Systemic Action -animal

BIONOMICS AND CONTROL OF ASIAN MOSQUITOES - ...4.0058

Systemic Action -plant

RELATIONSHIP OF PESTICIDES IN SOIL, WATER AND PLANTS ...1.0057
EVALUATION OF NEW INSECTICIDES ...2.0015
EXPANDED AQUATIC PLANT CONTROL PROJECT ...2.0146

Tannic Acid

TIME-CONCENTRATION TESTS INVOLVING NEUTRALIZATION OF ROTENONE WITH POTASSIUM PERMANGANATE ...2.0224

Tannin

BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...1.0083
ANAEROBIC DEGRADATION OF AROMATIC COMPOUNDS IN THE MARINE ENVIRONMENT ...1.0131

Tanzania

RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070

Taste & Odor of Water

EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155

Taxonomy -animal

ECOLOGY AND CONTROL OF CERTAIN PARASITIC DIPTERA ...2.0001
POPULATION GENETICS AND RADIOGENETICS IN MOSQUITOES ...2.0038
BIOLOGICAL AND SYSTEMATIC STUDIES ON AQUATIC ARTHROPODS ...2.0054
SURVEY OF INSECT PROBLEMS IN MONTANA ...2.0059
STUDIES ON SOME FUNGAL PARASITES OF MOSQUITOES ...2.0072
BIOLOGY OF THE LARVAL SEA LAMPREY ...2.0210
MOSQUITOES OF MIDDLE AMERICA ...4.0037
MOSQUITOES OF MIDDLE AMERICA ...4.0038
ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...4.0044
MOSQUITOES OF THE NEW GUINEA AREA ...4.0050
OCCURRENCE AND BIONOMICS OF BLOODSUCKING MIDGES (DIPTERA: CERATOPOGONIDAE) IN IOWA ...4.0056
MOSQUITOES OF MALAYSIA ...4.0060
AQUATIC & SEMI-AQUATIC DIPTERA STUDIES ...4.0073

Taxonomy -plant

DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...2.0094
CONTROL AND UTILIZATION OF AQUATIC PLANTS ...2.0157
STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...4.0022
AQUATIC PLANTS OF POLLUTED WATERS IN SOUTHWESTERN UNITED STATES ...4.0028

Technique Development

RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019
TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ...4.0030

Temperature - Air

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081
FATE OF HERBICIDES IN PLANTS AND SOILS ...1.0095
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0168
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191
FACTORS AFFECTING ROLE OF MICROORGANISMS IN BIOLOGICAL CONTROL OF INSECT PESTS ...2.0037
EMERGENCY INSECT CONTROL ...2.0076
DISTRIBUTION AND ECOLOGY OF PENNSYLVANIA SALAMANDERS ...2.0080
THE TOXICITY AND DETOXIFICATION OF THE ROTENONE FORMULATIONS USED IN FISH MANAGEMENT ...2.0226
BIOLOGY AND CONTROL OF TERRESTRIAL MOLLUSCS ...2.0281
ANATOMICAL, PHYSIOLOGICAL AND ECOLOGICAL STUDIES ON MYRIOPHYLLUM SPICATIU ...4.0013
THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...4.0052
DYNAMICS, BEHAVIOR AND IMPACT OF ECONOMIC INSECTS ...4.0053
PHOTOPERIOD AND TEMPERATURE EFFECTS ON DIAPAUSE OF THE MOSQUITO CULISETA INORNATA ...4.0074
POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078

Freezing & Below

EFFECT OF CONTROLLING SALT-MARSH MOSQUITOES ...2.0082

Low Temp. -but Above 32 F

LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010
BIONOMICS OF SELECTED NORTH AMERICAN CULICINE MOSQUITOES ...4.0054

Temperature - Soil

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010
SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL ...1.0012
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013
RESIDUES OF SELECTED PESTICIDES IN PLANTS, ANIMALS, AND THE PHYSICAL ENVIRONMENT ...1.0019
MOVEMENT OF HERBICIDES IN SOIL BY MASS FLOW ...1.0044
SOIL AND WATER MANAGEMENT FOR SALINITY CONTROL - PHASE II ...1.0066
EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...1.0074
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0105
SORPTION AND DESORPTION OF CHLORINATED HYDROCARBON PESTICIDES IN AQUATIC SEDIMENT MINERALS ...1.0181
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191
THE CONTROL OF SLUGS ...2.0294

High Temp. - 85 F or Above

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0009

Temperature - Water

PROPERTIES OF TILE DRAINAGE WATER ...1.0045
AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117
EFFECTS OF CHEMICAL IMPURITIES IN WATER DISINFECTION BY HALOGENS ...1.0155
ADSORPTION OF PESTICIDES FROM SEA WATER ...1.0159
GROUND AND SURFACE WATERS - POLLUTION ...1.0182
DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215
EFFECTS OF PESTICIDES ON AQUATIC ANIMALS IN THE ESTUARINE AND MARINE ENVIRONMENTS ...1.0234
RESEARCH STUDY ON THE EFFECTS OF POLLUTION ON SUB-TROPICAL FISH AND CRUSTACEANS ...1.0237
BEHAVIOR OF ESTUARINE ANIMALS ...1.0240
SCREENING OF PESTICIDES AGAINST FISH AT COLUMBIA MISSOURI ...1.0277
THE INFLUENCES OF ENVIRONMENTAL CONDITIONS ON THE TOXICITY OF PESTICIDES ...1.0278
THE SUSCEPTIBILITY OF VARIOUS LIFE STAGES OF FRESHWATER FISHES TO THREE TOXICANTS ...1.0279
RELATIVE SUSCEPTIBILITIES OF FISH FAMILIES TO HERBICIDES ...1.0280
INVESTIGATION OF STRESS-INDUCED MOBILIZATION OF INSECTICIDE RESIDUES - CHRONIC TOXICITY OF PESTICIDES TO FISH ...1.0281
CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...1.0285
CONTINUOUS-FLOW BIOASSAY OF PESTICIDES TO EVALUATE THE ACUTE AND CHRONIC EFFECTS OF PESTICIDES TO FRESHWATER INVERTEBRATES ...1.0294
BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...1.0303
STATIC BIOASSAY OF TRACERS AND DYES AGAINST FISH AND INVERTEBRATES ...1.0316
ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...1.0326
ECOLOGICAL STUDIES OF WILDLIFE MANAGEMENT PRACTICES ...1.0327
AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...1.0343
EFFECT OF COPPER SULFATE ON AQUATIC WEEDS ...2.0108
BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115
INFLUENCE OF PESTICIDES & OTHER HYDROCARBONS ON GROWTH OF EURYTOLERANT MICROALGAE ...2.0148
INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...2.0167
EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168
EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...2.0171
THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174
NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...2.0180
BIOLOGICAL AND LIMNOLOGICAL INVENTORY OF SEVEN FLOOD CONTROL RESERVOIRS IN THE STATE OF INDIANA ...2.0199
BIOLOGY OF THE LARVAL SEA LAMPREY ...2.0210
BIOASSAY ...2.0211
THE EFFICACY OF NEW FORMULATIONS OF ANTIMYCIN IN NATURAL LAKES AND STREAMS ...2.0246
STATIC BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0255
STATIC BIOASSAY OF REPRODUCTIVE CONTROLS AGAINST FISH AND INVERTEBRATES ...2.0256
STATIC BIOASSAY OF COLLECTING AIDS AGAINST FISH ...2.0257
STATIC BIOASSAY OF ATTRACTANTS AND REPELLANTS AGAINST FISH AND INVERTEBRATES ...2.0258
CONTINUOUS FLOW BIOASSAY OF TOXICANTS AGAINST FISH AND INVERTEBRATES ...2.0259
NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...2.0271
SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...2.0278
SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...2.0279
METHOD OF CONTROLLING MORTALITY IN CHANNEL CATFISH DUE TO CCV INFECTION ...3.0005
PATHOLOGY OF AEROMONAS LIQUIFACIENS IN CHANNEL CATFISH ...3.0013
COOPERATIVE FISH PARASITE AND DISEASE STUDY ...3.0015
OYSTER DISEASE MORTALITY ALONG THE CALIFORNIA COAST ...3.0022
ETIOLOGY OF ESTUARINE FISH DISEASES ...3.0040
MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...3.0060
USE OF CELL CULTURE METHODS TO ATTEMPT TO FOLLOW DEVELOPING STAGES OF SPORES ...3.0062
SALT WATER POND RESEARCH ...3.0073
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082
EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...3.0083
MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...3.0106
RELATIONSHIP OF TEMPERATURE TO DISEASES OF SALMONID FISH ...3.0116
CONTROL OF VIBRIOSIS IN SALMON ...3.0117
RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY ...4.0002
TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005
AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...4.0011
BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...4.0012
THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0020
ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024
ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...4.0039
WATER QUALITY REQUIREMENTS OF AQUATIC INSECTS ...4.0066
POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078
GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081
REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES ...4.0083

High Temp. -85 F or Above

BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...2.0269

Low Temp. -but Above 32 F

BIOLOGICAL CONTROL OF MOSQUITOES IN CENTRAL AND NORTHERN CALIFORNIA ...2.0006
CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...2.0154
ENVIRONMENTAL STUDY ...3.0030
THE RELATIONSHIP OF TEMPERATURE TO DISEASE OF SALMONID FISHES ...3.0051
AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...3.0126

Warm Water

Induced Temperature

PHYSICAL AND CHEMICAL FACTORS AFFECTING FISH ...1.0246

THE EFFECTIVENESS OF MCN-JR-7464 AS AN ANESTHETIC FOR SELECTED SPECIES OF FISH (ABBREV) ...2.0261
EFFECTS OF WATER EXCHANGE AND BLUE CRAB CONTROL ON SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IMPOUNDMENTS ...2.0275
RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT FINGERLINGS TO FURUNCULOSIS ...3.0041
PARASITES OF FRESH-WATER FISHES IN NORTH CAROLINA ...3.0047
THE RELATIONSHIP OF TEMPERATURE TO DISEASE OF SALMONID FISHES ...3.0051
AQUICULTURE, SALMON CULTURE - RESEARCH ...3.0053
EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...3.0089
AQUICULTURE, OYSTER HATCHERIES - RESEARCH ...3.0118

Warm Temperature -natural

CHRONIC EFFECTS OF DURSBAN ON WARM-WATER FISH ...1.0282
EFFECTS OF PARATHION AND MALATHION ON WARM-WATER FISH PONDS ...1.0283
EVALUATE FISH TOXICANTS (SUNSET LAKE SEGMENT) ...2.0229
STUDY OF THE INCIDENCE AND LIFE CYCLES OF MYXOSPORIDIAL INFECTIONS IN WARM WATER FISHES (REVISED) ...3.0020
ENVIRONMENTAL STUDY ...3.0030
PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...3.0108
AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...3.0126

Terpenes

MAGNITUDE AND NATURE OF POLYCHLORINATED BIPHENYLS IN COHO SALMON ...1.0262
CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266

Texas

FATE OF POLLUTANTS IN GROUND WATER ...1.0079
EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...1.0100
INVESTIGATION OF RICE IRRIGATION RETURN FLOWS - TEXAS COASTAL PRAIRIE REGION ...1.0209
ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...2.0083

Thailand

RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070
ASSESSMENT OF THE IMPORTANCE OF FILARIASIS IN THAILAND ...4.0072

Thymidine

RADIATION CYTOGENETICS OF THE YELLOW-FEVER MOSQUITO, AEDES AEGYPTI ...2.0036

Tidewater Areas

PESTICIDE KINETICS ...1.0127
ECOLOGICAL STUDIES OF WILDLIFE MANAGEMENT PRACTICES ...1.0327
MOSQUITO CONTROL - TIDAL MARSHES ...2.0063

Timing of Pest Control

CHANGES IN WATER ENVIRONMENT RESULTING FROM AQUATIC PLANT CONTROL ...2.0183

Tissues -biological

RELATION OF AGRICULTURAL PRACTICES TO WATER QUALITY IN NORTH APPALACHIAN REGION ...1.0194
THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...1.0365
TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ...4.0030

Histochemistry & Cytochemistry

ENZYME AND TISSUE ALTERATIONS IN FISH - A MEASURE OF WATER QUALITY ...1.0248
THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...4.0052

Histology and Cytology

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260
SCREENING PESTICIDES FOR TERATOGENIC EFFECTS ON GAMBUSIA - CHRONIC TOXICITY OF PESTICIDES TO FRESHWATER FISHES ...1.0268
COMPARISON OF METHODS USED TO MEASURE ESTERASE ACTIVITY. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...1.0274
SEASONAL CHANGES IN ESTERASE ACTIVITY IN FISH AND INVERTEBRATES. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...1.0275
EFFECTS OF PARATHION AND MALATHION ON WARM-WATER FISH PONDS ...1.0283
EFFECTS OF METHOXYCHLOR ON THE CONDITIONING OF STRIPED BASS TO AN OLFACTORY STIMULUS ...2.0233
TRANSMISSION OF AN OVARY PARASITE OF THE GOLDEN SHINER ...3.0038
CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045
MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...3.0060
A HISTOLOGIC STUDY OF MARINE FISH ...3.0076
HISTOPATHOLOGY OF SALMONID FISHES - BACTERIAL RED-MOUTH DISEASE HISTOPATHOGENESIS OF RAINBOW TROUT (SALMON GAIRDNERI) ...3.0093
NEOPLASMS OF SALMONID FISHES ...3.0094
HISTOPATHOLOGY OF SALMONID FISHES: DIAGNOSIS ...3.0095
BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...4.0012
THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...4.0052

Hypertrophy - Hyperplasia

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045

Leaf Analysis

DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...1.0196
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...2.0160

Transplants

EPIDERMAL PAPILLOMAS ...3.0021

Toxic Substances

Aflatoxins

MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...3.0056
HISTOPATHOLOGY OF LIVERS OF RAINBOW TROUT FED RANCID PELLETS CONTAINING AFLATOXIN ...3.0081

Aspertoxin

MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...3.0056

Bacterial Endotoxins

THE EFFECTS OF DIFFERENTLY EXTRACTED ENDOTOXINS FROM ESCHERICHIA COLI ON RAINBOW TROUT (SALMO GAIRDNERI) ...3.0071

Bacterial Toxins -nonspecific

CYTOPATHOGENIC EFFECT OF TOXIN ON TISSUE ...3.0086

CYTOPATHOGENIC EFFECT OF TOXIN IN FISH ...3.0087

Fungal Toxins

TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...2.0007

IDENTIFICATION AND CHARACTERIZATION OF MOSQUITO PATHOGENS ...2.0020

MODE OF ACTION OF A NEW FUNGAL PATHOGEN OF MOSQUITOES ...2.0070

MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...3.0056

Ochratoxin

MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...3.0056

Plant Toxins

MOSQUITO PATHOGENS AS POTENTIAL CONTROL AGENTS ...2.0019

TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005

Toxic Substances -nonspecific

IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD ...1.0123

EFFECTS OF TOXICANTS UPON FISH MOVEMENT PATTERNS ...1.0308

CHEMOTHERAPEUTIC CONTROL OF SCHISTOSOMIASIS BY HORMONES ...2.0266

Toxicity to Microorganisms

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0023

REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0037

PESTICIDE DETOXICATION MECHANISMS OF MICROORGANISMS IN SOIL AND WATER ...1.0087

PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN ...1.0213

MICROBIOLOGY OF FARM PONDS ...1.0220

THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...1.0297

ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...1.0326

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...1.0334

EFFECTS OF PESTICIDES ON NON-TARGET ORGANISMS ...1.0341

THE EFFECT OF PESTICIDES ON PRIMARY PRODUCERS IN A FRESHWATER ECOSYSTEM ...1.0350

INTERCEPTION AND DEGRADATION OF PESTICIDES BY AQUATIC ALGAE ...1.0363

MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...2.0060

ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0117

THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...2.0150

ALGACIDES FOR USE IN WATER RECLAMATION AND REUSE SYSTEMS ...2.0177

Tracers

IMPACT ON MAN OF ENVIRONMENTAL CONTAMINATION CAUSED BY LEAD ...1.0123

Dyes

DEVELOPMENT OF RHODAMINE-B DYE TO TRACE FLOW AND DISPERSION PATTERNS IN STREAMS AS AN ADJUNCT TO TREATING STREAMS WITH FISH-CONTROL CHEMICALS ...2.0245

Radioisotopes

THE CYCLING OF CL-36 LABELED DDT IN NATURAL ECOSYSTEMS ...1.0078

DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...1.0333

FARM FISH POND MANAGEMENT ...1.0340

Training Grants, Fellowships

OYSTER DISEASE MORTALITY ALONG THE CALIFORNIA COAST ...3.0022

BACTERIAL AND VIRAL DISEASES AND CELL CULTURES OF MARINE FISH AND SHELLFISH ...3.0074

Transducers

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...2.0096

Transportation Engineering

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086

STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES ...1.0142

EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...2.0267

Snow and Ice Removal

STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES ...1.0142

Trucks

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183

Trichloracetic Acid

THE EFFECTS OF DIFFERENTLY EXTRACTED ENDOTOXINS FROM ESCHERICHIA COLI ON RAINBOW TROUT (SALMO GAIRDNERI) ...3.0071

Turbidity - Water

INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0116

AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117

GROUND AND SURFACE WATERS - POLLUTION ...1.0182

QUANTITATIVE METHODS FOR PESTICIDES IN NATURAL WATERS ...1.0198

BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342

DETERMINATION OF THE EFFECTS OF A FERTILIZER-INDUCED PLANKTON TURBIDITY, SUPPLEMENTED BY HERBICIDES, ON SUBMERGED AQUATIC PLANTS ...2.0137

CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...2.0154

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168

BIOASSAY ...2.0211

MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...3.0060

AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...4.0011
GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081

Turf

RELATIVE LEACHING RATES OF COMMON NITROGEN CARRIERS FROM SANDY SOILS IN RELATION TO LAKE EUTROPHICATION ...4.0006

Ultrafiltration

CONCENTRATION AND ANALYSIS OF PESTICIDES AND OTHER RECALCITRANT MOLECULES IN WATER SUPPLIES BY ULTRAFILTRATION ...1.0185

Ultrasonic Frequencies

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...2.0096

United Arab Republic

MOSQUITO AND HOUSEFLY CONTROL WITH CHEMOSTERILANTS IN EGYPT ...2.0085

United States of Indonesia

INTERSPECIFIC COMPETITION AMONG MOSQUITOES ...2.0047

Urban Research

STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES ...1.0142
AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...1.0161
QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187
CENTER FOR STUDY OF THE HUMAN ENVIRONMENT ...1.0190
TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE ...1.0201
DEVELOPMENT AND BEHAVIOR OF BITING DIPTERA ...2.0023
SURVEY OF INSECT PROBLEMS IN MONTANA ...2.0059
RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070
CALIFORNIA ENCEPHALITIS VIRUS IN WISCONSIN ...4.0075

Urea

SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0273

Urethanes

CONTROL OF HAZARDOUS CHEMICAL SPILLS BY PHYSICAL BARRIERS ...1.0086

Uric Acid

SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...1.0273

Urine

THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...1.0365
ROUTE(S) OF EXCRETION OF QUINALDINE SULFATE, A FISH ANESTHETIC ...2.0249

Utah

EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029

Vaccines

CONTROL OF VIBRIOSIS IN SALMON ...3.0117

Bacterial Vaccine
  INFECTIOUS DISEASES OF SALMONID FISHES ...3.0049
  ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - RED MOUTH COMPARATIVE VACCINE STUDY ...3.0085
  CONTROL OF VIBRIOSIS IN SALMON ...3.0117
  ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - FURUNCULOSIS IN COHO SALMON ...3.0122

Rickettsial Vaccine
  TRANSMISSION OF ANAPLASMOSIS ...4.0032

Viral Vaccines
  EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...3.0119

Venezuela

MOSQUITOES OF MIDDLE AMERICA ...4.0037

Vertebrate Anatomy

ENZYME AND TISSUE ALTERATIONS IN FISH - A MEASURE OF WATER QUALITY ...1.0248
ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...2.0089

Vertebrate Nutrition

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029
IMPROVEMENT OF SALMON AND STEELHEAD TROUT HATCHERY TECHNIQUES ...3.0059

Diet Components -animal

  Carbohydrates
    MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...3.0056
  Inorganic Elements
    BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...1.0303
    MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...3.0056
  Proteins and Amino Acids
    NUTRITIONAL FACTORS IN THE DEVELOPMENT OF CORYNEBACTERIAL KIDNEY DISEASE ...3.0090
  Vitamins
    MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...3.0056

Digestion -animal

  Biological
    PROCESSING, CHEMICAL COMPOSITION, AND NUTRITIVE VALUE OF AQUATIC WEEDS ...2.0119
  Malabsorption Syndrome
    PROCESSING, CHEMICAL COMPOSITION, AND NUTRITIVE VALUE OF AQUATIC WEEDS ...2.0119

Fasting - Starvation
  INVESTIGATION OF STRESS-INDUCED MOBILIZATION OF INSECTICIDE RESIDUES - CHRONIC TOXICITY OF PESTICIDES TO FISH ...1.0281

Regulation and Selection

PROCESSING, CHEMICAL COMPOSITION, AND NUTRITIVE VALUE OF AQUATIC WEEDS ...**2.0119**

Tests and Methods

MYCOTOXIN TOXICITY AND CARCINOGENESIS IN TROUT ...**3.0056**

Therapeutic Nutrition

ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - FURUNCULOSIS IN COHO SALMON ...**3.0122**

Toxic & Allergenic Effects

THE UPTAKE OF AND BIOLOGICAL RESPONSES TO AROCLORS IN CHANNEL CATFISH ...**1.0267**

CHRONIC TOXICITY OF PESTICIDES TO COLD-WATER FISH ...**1.0318**

PROCESSING, CHEMICAL COMPOSITION, AND NUTRITIVE VALUE OF AQUATIC WEEDS ...**2.0119**

Vertebrate Physiology

THE EFFECTS OF THANITE ON THE ACID-BASE BALANCE IN THE BLOOD OF FISHES ...**2.0254**

IMPROVEMENT OF SALMON AND STEELHEAD TROUT HATCHERY TECHNIQUES ...**3.0059**

Aging -vertebrate

LAKE SUPERIOR COMMERCIAL FISHERIES ASSESSMENT STUDIES ...**2.0212**

Behavior -vertebrate

BEHAVIOR OF ESTUARINE ANIMALS ...**1.0240**

RELATIONSHIPS BETWEEN SUB-LETHAL PESTICIDES AND REPRODUCTION AND BEHAVIOR OF FISHES ...**1.0245**

TOXICITY OF SELECTED METALS TO CONDITIONED FISH ...**1.0302**

TOXICOLOGY OF PESTICIDES IN THE ENVIRONMENT ...**1.0360**

THE USE OF PHEROMONES BY CARP, CYPRINUS CARPIO-RESEARCH ...**2.0217**

EFFECTS OF METHOXYCHLOR ON THE CONDITIONING OF STRIPED BASS TO AN OLFACTORY STIMULUS ...**2.0233**

Biological Rhythms

MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...**3.0106**

Spawning

PESTICIDE RESIDUE EFFECTS ON LARVAL MARINE FISHES ...**1.0254**

LABORATORY BIOASSAYS TO DETERMINE TOXIC EFFECS OF METHOXYCHLOR IN FISH ...**1.0264**

POPULATION DYNAMICS - LAKE TROUT ...**2.0235**

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...**3.0029**

SPAWNING AND REARING OF MARINE FISH ...**3.0110**

EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...**3.0119**

GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...**4.0081**

REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES ...**4.0083**

Blood-lymph-re-system

Blood -other

EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH ...**2.0260**

EVALUATION OF STRESS IN FINGERLING SALMON THERAPEUTIC DRUGS AS STRESS FACTORS ...**3.0120**

Blood Cells

EVALUATION OF STRESS IN FINGERLING SALMON THERAPEUTIC DRUGS AS STRESS FACTORS ...**3.0120**

Blood Protein

DEVELOPMENTS OF METHODS RELATED TO TESTING OF FISH CONTROL AGENTS BIOCHEMICAL METHOD FOR SEXING FISH ...**2.0248**

EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...**3.0089**

EVALUATION OF STRESS IN FINGERLING SALMON THERAPEUTIC DRUGS AS STRESS FACTORS ...**3.0120**

Spleen

HISTOPATHOLOGY OF SALMONID FISHES - BACTERIAL RED-MOUTH DISEASE HISTOPATHOGENESIS OF RAINBOW TROUT (SALMON GAIRDNERI) ...**3.0093**

Digestive System

Digestive -other

SUSCEPTIBILITY OF VARIOUS AGES OF FISH TO INFECTION ...**3.0063**

Liver and Gall Bladder

CHRONIC TOXICITY OF PESTICIDES TO FISH ...**1.0287**

ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...**2.0089**

DEVELOPMENTS OF METHODS RELATED TO TESTING OF FISH CONTROL AGENTS BIOCHEMICAL METHOD FOR SEXING FISH ...**2.0248**

INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...**2.0280**

HISTOPATHOLOGY OF LIVERS OF RAINBOW TROUT FED RANCID PELLETS CONTAINING AFLATOXIN ...**3.0081**

EFFICACY OF A POTENTIATED SULFONAMIDE AGAINST FURUNCULOSIS INFECTIONS IN JUVENILE RAINBOW TROUT AND COHO SALMON ...**3.0125**

Stomach

ECOLOGY AND DISEASE TRANSMISSION POTENTIAL ...**4.0044**

Endocrine System

Endocrine -other

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0269**

SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0273**

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0288**

Exogenoris

THE USE OF PHEROMONES BY CARP, CYPRINUS CARPIO-RESEARCH ...**2.0217**

Nerve - Neuro Secretion

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0291**

Pituitary

EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...**2.0234**

Thyroid

THE UPTAKE OF AND BIOLOGICAL RESPONSES TO AROCLORS IN CHANNEL CATFISH ...**1.0267**

THYROIDAL I125 UPTAKE IN IMMATURE CHANNEL CATFISH FOLLOWING EXPOSURE TO SELECTED TOXICANTS ...**1.0272**

CHRONIC TOXICITY OF PESTICIDES TO COLD-WATER FISH ...**1.0318**

Environmental Physiology

RELATIONSHIPS BETWEEN SUB-LETHAL PESTICIDES AND REPRODUCTION AND BEHAVIOR OF FISHES ...**1.0245**

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...**1.0249**

FIELD STUDIES OF PESTICIDE EFFECTS ON FISHES ...**1.0257**

TOXICITY OF SELECTED METALS TO CONDITIONED FISH ...**1.0302**

EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH ...**2.0260**

UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...**3.0029**

ETIOLOGY OF ESTUARINE FISH DISEASES ...**3.0040**

BACTERIAL FLORA OF APPARENTLY HEALTHY STRIPED BASS (ROCCUS SAXATILIS) & ITS CORRELATION WITH THE BACTERIA OF THE HATCHERY WATER SUPPLY ...**3.0046**

EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...**3.0083**

MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...**3.0106**

REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES ...**4.0083**

Immunology

EPIZOOTIOLOGY OF PARASITIC DISEASES IN FISH POPULATIONS UNDER INTENSIVE MANAGEMENT ...**3.0001**

RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT FINGERLINGS TO FURUNCULOSIS ...**3.0041**

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...**3.0045**

INFECTIOUS DISEASES OF SALMONID FISHES ...**3.0049**

ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - RED MOUTH COMPARATIVE VACCINE STUDY ...**3.0085**

CYTOPATHOGENIC EFFECT OF TOXIN ON TISSUE ...**3.0086**

CYTOPATHOGENIC EFFECT OF TOXIN IN FISH ...**3.0087**

DETECTION OF CARRIER CONDITION IN FURUNCULOSIS ...**3.0098**

PARASITOLOGY - PARASITES AND PARASITIC DISEASES OF FISHES - IMMUNIZATION STUDY FOR ICHTHYOPHTHIRIUS ...**3.0100**

PARASITES OF WARMWATER FISHES AND THEIR CONTROL ...**3.0108**

ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - FURUNCULOSIS IN COHO SALMON ...**3.0122**

Locomotion -animal

EFFECTS OF CHRONIC SUBLETHAL DOSAGES OF DDT ON THE SWIMMING PERFORMANCE OF ATLANTIC SALMON PARR ...**1.0252**

EFFECTS OF TOXICANTS UPON FISH MOVEMENT PATTERNS ...**1.0308**

SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...**2.0206**

Metabolism -vertebrate

CHEMICAL ANALYSES ...**1.0129**

LIVESTOCK DETOXICATING MECHANISMS OF PESTICIDES ...**1.0212**

ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...**1.0239**

FACTORS AFFECTING PESTICIDE TOXICITY ...**1.0255**

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...**1.0260**

SEASONAL CHANGES IN ESTERASE ACTIVITY IN FISH AND INVERTEBRATES. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...**1.0275**

INVESTIGATION OF STRESS-INDUCED MOBILIZATION OF INSECTICIDE RESIDUES - CHRONIC TOXICITY OF PESTICIDES TO FISH ...**1.0281**

PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0288**

PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...**1.0289**

PESTICIDE EFFECTS ON NITROGEN METABOLISM IN TELEOSTS ...**1.0290**

UPTAKE AND METABOLISM BY FISH OF 2,4-D DIMETHYL AMINE SALT ...**1.0293**

EFFECTS OF PESTICIDES ON ESTUARINE ORGANISMS ...**1.0305**

TOXICOLOGY OF PESTICIDES IN THE ENVIRONMENT ...**1.0360**

THE EFFECTS OF TFM ON THE BLOOD CHEMISTRY OF FISHES ...**2.0252**

THE EFFECTS OF ANTIMYCIN A ON THE METABOLISM OF SELECTED TISSUES IN FISH (ABBREV) ...**2.0262**

BIOCHEMICAL CHANGES IN FISH DISEASES - THE STRESS OF FORMALIN TREATMENTS IN SALMONID FISHES ...**3.0124**

COMPARISONS BETWEEN ARTHROPOD AND VERTEBRATE METABOLISM ...**4.0049**

Energy

SPAWNING AND REARING OF MARINE FISH ...**3.0110**

Inhibitors

EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH ...**2.0260**

Mineral

MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...**1.0292**

Metamorphosis -animal

SEA LAMPREY CONTROL - AGE AND GROWTH STUDIES ...**2.0206**

DEVELOPMENT OF METHODS FOR COMMERCIAL PRODUCTION OF FROG LEGS FROM TADPOLES OF THE BULLFROG ...**3.0028**

Musculoskeletal System

Bone

THE UPTAKE OF AND BIOLOGICAL RESPONSES TO AROCLORS IN CHANNEL CATFISH ...**1.0267**

WALLEYE LIFE HISTORY STUDY ...**4.0085**

Cartilage

TRANSMISSION OF MYXOSOMA CEREBRALIS AND OTHER CARTILAGINOUS MYXOSPORIDA ...**3.0132**

Muscle

QUALITY FACTORS OF LAKE MICHIGAN COHO SALMON FLESH ...**1.0259**

PESTICIDE LEVELS IN BIRDS WINTERING ON LAKE MICHIGAN ...**1.0367**

Nervous System -vertebrate

ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...**1.0239**

NERVE IMPULSE TRANSMISSION CHARACTERISTICS OF ISOLATED FISH-NERVE PREPARATIONS PERFUSED WITH PHYSIOLOGICAL LEVELS OF SELECTED PESTICIDES ...**1.0271**

COMPARISON OF METHODS USED TO MEASURE ESTERASE ACTIVITY. INTERACTIONS BETWEEN PESTICIDES ON FISH ENZYME SYSTEMS ...**1.0274**

MINERAL IMBALANCE IN BLUEGILLS EXPOSED TO MALATHION PESTICIDE-INDUCED MINERAL IMBALANCE IN FISH ...**1.0292**

IN VITRO POTENCY OF SEVERAL ANTICHOLINESTERASE AGENTS WITH SELECTED MEMBERS OF THE AQUATIC ENVIRONMENT ...**1.0348**

THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...**1.0365**

ACTION MECHANISMS OF INSECTICIDAL DERIVATIVES ...**2.0089**

USE OF CELL CULTURE METHODS TO ATTEMPT TO FOLLOW DEVELOPING STAGES OF SPORES ...**3.0062**

SUSCEPTIBILITY OF VARIOUS AGES OF FISH TO INFECTION ...**3.0063**

UTILIZATION OF INVERTEBRATE VECTORS IN THE TRANSMISSION OF WHIRLING DISEASE ...**3.0064**

USE OF TISSUE SECTIONING TECHNIQUES TO ATTEMPT TO FOLLOW THE LIFE HISTORY OF WHIRLING DISEASE PARASITES FROM THE FIRST DAY OF INFECTION ...**3.0065**

TREATMENT OF WHIRLING DISEASE SPORES TO PRODUCE INFECTIVE STATES OF THE ORGANISM ...**3.0066**

METHODS OF COLLECTING AND CONCENTRATING SPORES TAKEN FROM INFECTED FISH ...**3.0067**

DETERMINE IF SPORES OR INFECTIVE STAGES ARE SHED FROM LIVING FISH ...**3.0068**

LONGEVITY OF SPORES OF 'MYOXOSOMA CEREBRALIS' (WHIRLING DISEASE) ...**3.0102**

POSSIBLE BIRD TRANSMISSION OF 'MYXOSOMA CEREBRALIS' ...**3.0105**

Osmoregulation

SERUM ANALYSIS OF CUTTHROAT TROUT EXPOSED CHRONICALLY TO METHOXYCHLOR PESTICIDE EFFECTS ON FISH ENDOCRINE FUNCTIONS ...**1.0273**

EFFECTS OF FISH CONTROL AGTS ON BLOOD CHEM & HEMATOPOIETIC TISSUE OF FISH. EFFECTS OF ANTIMYCIN A. ON ACID-BASE BALANCE IN BLOOD OF FISH ...**2.0260**

MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...**3.0106**

Respiratory System

Fish

DISTRIBUTION OF THE GENUS ERGASILUS (PARASITIC COPEPOD) IN THE SOUTHEASTERN UNITED STATES ...**3.0011**

COOPERATIVE FISH PARASITE AND DISEASE STUDY ...**3.0015**

EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...**3.0083**

EFFICACY OF A POTENTIATED SULFONAMIDE AGAINST FURUNCULOSIS INFECTIONS IN JUVENILE RAINBOW TROUT AND COHO SALMON ...**3.0125**

AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...**3.0126**

Sensory Organs -vertebrate

BEHAVIOR OF ESTUARINE ANIMALS ...**1.0240**

THE USE OF PHEROMONES BY CARP, CYPRINUS CARPIO-RESEARCH ...**2.0217**

EFFECTS OF METHOXYCHLOR ON THE CONDITIONING OF STRIPED BASS TO AN OLFACTORY STIMULUS ...**2.0233**

Skin or Special Derivatives

EPIDERMAL PAPILLOMAS ...**3.0021**

ANALYSIS OF DATA AND PREPARATION OF MANUSCRIPTS FOR PUBLICATION ...**3.0044**

EFFICACY OF A POTENTIATED SULFONAMIDE AGAINST FURUNCULOSIS INFECTIONS IN JUVENILE RAINBOW TROUT AND COHO SALMON ...**3.0125**

DEVELOPMENT OF AN ORALLY EFFECTIVE INSECT REPELLENT ...**4.0051**

Dermal

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...**3.0045**

ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - FURUNCULOSIS IN COHO SALMON ...**3.0122**

Scales

EARLY SQUAMATION OF BLUEGILL (LEPOMIS MACROCHIRUS) AND FATHEAD MINNOWS (PIMEPHALES PROMELAS) EXPOSED TO AROCLORS ...**1.0286**

LAKE SUPERIOR COMMERCIAL FISHERIES ASSESSMENT STUDIES ...**2.0212**

Thermoregulation

EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...**3.0089**

Tissues -vertebrate

INHIBITORY EFFECT OF DDT IN ATPASE ASSAY MIXTURES ...**1.0309**

RESIDUES OF THANITE IN FISH MUSCLE ...**1.0314**

RESIDUES OF MS-222 IN FISH ...**2.0236**

U.V. SPECTROPHOTOMETRY FOR THE IDENTIFICATION AND ESTIMATION OF QUINALDINE RESIDUE ...**2.0237**

IN VIVO AND IN VITRO STUDIES ON THE MODE OF ACTION OF TFM ...**2.0250**

Urogenital System

Kidney and Urinary System

EFFECT OF ANESTHESIA ON THE BLOOD CHEMISTRY OF FISHES ...**2.0234**

NUTRITIONAL FACTORS IN THE DEVELOPMENT OF CORYNEBACTERIAL KIDNEY DISEASE ...**3.0090**

HISTOPATHOGENESIS OF KIDNEY DISEASE ...**3.0091**

HISTOPATHOLOGY OF SALMONID FISHES - BACTERIAL RED-MOUTH DISEASE HISTOPATHOGENESIS OF RAINBOW TROUT (SALMON GAIRDNERI) ...**3.0093**

EFFICACY OF A POTENTIATED SULFONAMIDE AGAINST FURUNCULOSIS INFECTIONS IN JUVENILE RAINBOW TROUT AND COHO SALMON ...**3.0125**

Reproductive System

EXPERIMENTALLY INDUCED INSECTICIDE RESISTANCE IN THE MOSQUITOFISH, GAMBUSIA AFFINIS ...**1.0249**

SUBLETHAL AMOUNTS OF ORGANIC INSECTICIDES AND FISH ...**1.0313**

REPRODUCTIVE PERFORMANCE OF FISH-EATING BIRDS IN NORTHERN CALIFORNIA ...**1.0320**

Veterinary Microbiology

Detection

CHARACTERIZATION OF THE INFECTIOUS PANCREATIC NECROSIS (IPN) VIRUS OF TROUT ...**3.0031**

DEVELOPMENT OF METHODS FOR RAPID IDENTIFICATION OF BACTERIAL FISH PATHOGENS ...**3.0097**

DETECTION OF CARRIER CONDITION IN FURUNCULOSIS ...**3.0098**

ISOLATION AND FURTHER DESCRIPTION OF THE SPORES OF MYXOSOMA CEREBRALIS ...**3.0101**

DIAGNOSIS OF DISEASES IN FISH ...**3.0107**

DIAGNOSIS OF DISEASES IN WILDLIFE ...**3.0134**

INSECTS AS VECTORS OF DISEASES OF MILITARY IMPORTANCE IN ETHIOPIA THEIR ECOLOGY AND CONTROL ...**4.0067**

Infectious Disease

ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...**2.0083**

SWIMMER'S ITCH - INTERMEDIATE HOSTS, DISTRIBUTION AND ECOLOGY ...**2.0278**

SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...**2.0279**

TREATMENT OF WHIRLING DISEASE SPORES TO PRODUCE INFECTIVE STATES OF THE ORGANISM ...**3.0066**

METHODS OF COLLECTING AND CONCENTRATING SPORES TAKEN FROM INFECTED FISH ...**3.0067**

ASSESSMENT OF THE IMPORTANCE OF FILARIASIS IN THAILAND ...**4.0072**

Septicemia

INSECTS AS VECTORS OF DISEASES OF MILITARY IMPORTANCE IN ETHIOPIA THEIR ECOLOGY AND CONTROL ...**4.0067**

Virulence and Pathogenicity

VIBRIO PARAHAEMOLYTICUS IN CHESAPEAKE BAY - ISOLATION, INCIDENCE AND PATHOGENICITY ...**3.0026**

PACIFIC OYSTER MORTALITY STUDIES ...**3.0034**

ORAL IMMUNIZATION OF HATCHERY-REARED SALMONIDS - RED MOUTH COMPARATIVE VACCINE STUDY ...**3.0085**

CONTROL OF VIBRIOSIS IN SALMON ...**3.0117**

AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS ...**3.0126**

Veterinary Science

BIOLOGY ECOLOGY AND CONTROL OF INSECTS TICKS AND MITES WHICH ATTACK LIVESTOCK, POULTRY AND HOUSEHOLD ...**2.0040**

BIOLOGY AND CONTROL OF ARTHROPOD PESTS OF LIVESTOCK ...**2.0057**

THE BIOLOGY AND CONTROL OF ARTHROPODS AFFECTING MAN AND ANIMALS ...**2.0078**

INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...**2.0087**

INCIDENCE BIOLOGY AND CONTROL OF FASCIOLA HEPATICA IN THE SOUTHWEST ...**2.0280**

EPIZOOTIOLOGY OF PARASITIC DISEASES IN FISH POPULATIONS UNDER INTENSIVE MANAGEMENT ...**3.0001**

INVESTIGATIONS OF AMEBIASIS IN FISH ...**3.0014**

COOPERATIVE FISH PARASITE AND DISEASE STUDY ...3.0015

EPIZOOTIOLOGY OF LEPTOSPIRES - FISH SUSCEPTIBILITY TO L. ICTEROHAEMORRHIGICA (ABBREV) ...3.0023

SURVEY OF ANIMAL DISEASES IN CONNECTICUT ...3.0024

DISEASES OF FISH ...3.0025

CHARACTERIZATION OF THE INFECTIOUS PANCREATIC NECROSIS (IPN) VIRUS OF TROUT ...3.0031

INFECTIOUS DISEASES OF SALMONID FISHES ...3.0049

BIOLOGY OF THE PROTOZOAN PARASITE CERATOMYXA SHASTA ...3.0050

EPIDEMOLOGY OF 'SALMON POISONING' DISEASE ...3.0054

IMPROVEMENT OF SALMON AND STEELHEAD TROUT HATCHERY TECHNIQUES ...3.0059

DETERMINE IF SPORES OR INFECTIVE STAGES ARE SHED FROM LIVING FISH ...3.0068

THE EFFECTS OF DIFFERENTLY EXTRACTED ENDOTOXINS FROM ESCHERICHIA COLI ON RAINBOW TROUT (SALMO GAIRDNERI) ...3.0071

BACTERIAL AND VIRAL DISEASES AND CELL CULTURES OF MARINE FISH AND SHELLFISH ...3.0074

A HISTOLOGIC STUDY OF MARINE FISH ...3.0076

NEOPLASMS OF SALMONID FISHES ...3.0094

DEVELOPMENT OF METHODS FOR RAPID IDENTIFICATION OF BACTERIAL FISH PATHOGENS ...3.0097

DIAGNOSIS OF DISEASES IN FISH ...3.0107

CONTROL OF VIBRIOSIS IN SALMON ...3.0117

IN VIVO CHEMOTHERAPEUTIC STUDIES ON FISH PATHOGENIC BACTERIA ...3.0121

TRANSMISSION OF ANAPLASMOSIS ...4.0032

CULTIVATION OF INSECT PHASE OF AVIAN PLASMODIA ...4.0036

BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...4.0045

BIONOMICS OF MARYLAND MOSQUITOES ...4.0063

A STUDY IN INSECT TRANSMISSION OF ANAPLASMOSIS ...4.0064

MOSQUITOES AS VECTORS OF LIVESTOCK DISEASES ...4.0065

Viral and Rickettsial Studies

Assay

ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...2.0083

BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS ...4.0061

Characterization

VERTEBRATE DISEASES - VIRAL DISEASES OF FRESHWATER FISHES AND OTHER LOWER VERTEBRATES EGTVED VIRUS ...3.0104

Biological Properties

ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...2.0083

Chemical Properties

VIRAL PATHOGENS ...2.0035

Physical Properties

BIOLOGY OF MICROORGANISMS OF MOSQUITOES ...2.0022

VIRAL PATHOGENS ...2.0035

Classification

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045

ARTHROPOD-BORNE VIRUS (ARBOVIRUS) ACTIVITY IN MAJOR MOSQUITO VECTORS IN IOWA ...4.0057

Concentration

BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS ...4.0061

Cytopathogenic Effect

Cytopathogenic Effect -nonspec

VIRAL PATHOGENS ...2.0035

ISOLATION OF VIRUSES FROM FISHES - INVESTIGATION OF FISH EPIZOOTICS OF UNKNOWN ETIOLOGY FOR POSSIBLE VIRUS INVOLVEMENT ...3.0084

Detection & Diagnosis

DEVELOPMENT OF NEW FISH CELL LINES ...3.0008

COOPERATIVE FISH DISEASE PROJECT ...3.0009

Isolation

ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...2.0083

A CRITICAL TEST OF METHODS FOR ISOLATION OF VIRUSES FOR USE IN CONTROL OF NUISANCE ALGAE ...2.0133

DETECTION OF CHANNEL CATFISH VIRUS (CCV) IN BROODSTOCK ...3.0004

SUSCEPTIBILITY OF OTHER SPECIES OF CATFISHES TO CCV AND THEIR POSSIBLE ROLE AS CARRIERS ...3.0007

COOPERATIVE FISH DISEASE PROJECT ...3.0009

COOPERATIVE FISH PARASITE AND DISEASE STUDY ...3.0015

ISOLATION OF VIRUSES FROM FISHES - INVESTIGATION OF FISH EPIZOOTICS OF UNKNOWN ETIOLOGY FOR POSSIBLE VIRUS INVOLVEMENT ...3.0084

ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046

ARTHROPOD-BORNE VIRUS (ARBOVIRUS) ACTIVITY IN MAJOR MOSQUITO VECTORS IN IOWA ...4.0057

INSECTS AS VECTORS OF DISEASES OF MILITARY IMPORTANCE IN ETHIOPIA THEIR ECOLOGY AND CONTROL ...4.0067

CALIFORNIA ENCEPHALITIS VIRUS IN WISCONSIN ...4.0075

Multiplication & Replication

CHANNEL CATFISH VIRUS REPLICATION CURVES IN INTERNAL ORGANS AND ASSOCIATED PATHOLOGY ...3.0010

MULTIPLICATION OF ENTERIC VIRUSES IN SHELLFISH ...3.0069

Pathogenesis

ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046

Serology

VIRAL PATHOGENS ...2.0035

CHARACTERIZATION OF THE INFECTIOUS PANCREATIC NECROSIS (IPN) VIRUS OF TROUT ...3.0031

ARTHROPOD-BORNE VIRUS (ARBOVIRUS) ACTIVITY IN MAJOR MOSQUITO VECTORS IN IOWA ...4.0057

CALIFORNIA ENCEPHALITIS VIRUS IN WISCONSIN ...4.0075

Transmission

ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...2.0083

BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...4.0045

ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046

ARTHROPOD-BORNE VIRUS (ARBOVIRUS) ACTIVITY IN MAJOR MOSQUITO VECTORS IN IOWA ...4.0057

CALIFORNIA ENCEPHALITIS VIRUS IN WISCONSIN ...4.0075

Virulence

VERTEBRATE DISEASES - VIRAL DISEASES OF FRESHWATER FISHES AND OTHER LOWER VERTEBRATES EGTVED VIRUS ...3.0104

Virus - Host Specificity

A CRITICAL TEST OF METHODS FOR ISOLATION OF VIRUSES FOR USE IN CONTROL OF NUISANCE ALGAE ...2.0133

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045

ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046

Virus-like Particles

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045

Virgin Islands

MOSQUITOES OF MIDDLE AMERICA ...4.0037

Virginia

ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046

Viruses - Animal

Animal Viruses -nonspecific

INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0116

AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117

MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...2.0062

Arboviruses

MOSQUITOES IN RELATION TO AGRICULTURAL PRODUCTION AND VETERINARY SCIENCE ...2.0062

ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046

ARTHROPOD-BORNE VIRUS (ARBOVIRUS) ACTIVITY IN MAJOR MOSQUITO VECTORS IN IOWA ...4.0057

INSECTS AS VECTORS OF DISEASES OF MILITARY IMPORTANCE IN ETHIOPIA THEIR ECOLOGY AND CONTROL ...4.0067

California Encep Group

CALIFORNIA ENCEPHALITIS VIRUS IN WISCONSIN ...4.0075

Group A Arboviruses

ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046

BIONOMICS OF MARYLAND MOSQUITOES ...4.0063

Group B Arboviruses

ARBOVIRUS STUDIES--HOUSTON AND THE TEXAS GULF COAST ...2.0083

ECOLOGY AND CONTROL OF DISEASE VECTORS AND RESERVOIRS ...4.0046

BIOLOGY, GENETICS, AND PHYSIOLOGY OF DISEASE VECTORS ...4.0061

JAPANESE ENCEPHALITIS ON GUAM ...4.0062

RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070

Hemorrhagic Fevers

RESEARCH ON ARTHROPOD-BORNE DISEASES - I ...4.0070

Avian Leukosis

Lymphoid Leukosis

SURVEY OF ANIMAL DISEASES IN CONNECTICUT ...3.0024

DNA Viruses, Enveloped

Herpesvirus Group

SURVEY OF ANIMAL DISEASES IN CONNECTICUT ...3.0024

DNA Viruses, Naked

Papovaviruses

EPIDERMAL PAPILLOMAS ...3.0021

Picornaviruses

MULTIPLICATION OF ENTERIC VIRUSES IN SHELLFISH ...3.0069

RNA Viruses, Naked

Picornaviruses

CHARACTERIZATION OF THE INFECTIOUS PANCREATIC NECROSIS (IPN) VIRUS OF TROUT ...3.0031

Reoviruses

BLUETONGUE TRANSMISSION BY SAND FLIES AND MOSQUITOES ...4.0045

OCCURRENCE AND BIONOMICS OF BLOODSUCKING MIDGES (DIPTERA: CERATOPOGONIDAE) IN IOWA ...4.0056

Viruses of Fish

DEVELOPMENT OF NEW FISH CELL LINES ...3.0008

COOPERATIVE FISH DISEASE PROJECT ...3.0009

PUBLICATION OF FISH VIRUS RESEARCH ...3.0017

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045

VIRAL DISEASES OF MARINE FISHES ...3.0061

BACTERIAL AND VIRAL DISEASES AND CELL CULTURES OF MARINE FISH AND SHELLFISH ...3.0074

ISOLATION OF VIRUSES FROM FISHES - INVESTIGATION OF FISH EPIZOOTICS OF UNKNOWN ETIOLOGY FOR POSSIBLE VIRUS INVOLVEMENT ...3.0084

HISTOPATHOLOGY OF SALMONID FISHES - HISTOPATHOGENESIS OF CULTUS LAKE VIRUS DISEASE ...3.0092

HISTOPATHOLOGY OF SALMONID FISHES: DIAGNOSIS ...3.0095

VERTEBRATE DISEASES - VIRAL DISEASES OF FRESHWATER FISHES AND OTHER LOWER VERTEBRATES EGTVED VIRUS ...3.0104

Channel Catfish Virus

DETECTION OF CHANNEL CATFISH VIRUS (CCV) IN BROODSTOCK ...3.0004

METHOD OF CONTROLLING MORTALITY IN CHANNEL CATFISH DUE TO CCV INFECTION ...3.0005

EVALUATION OF THE INFLUENCE OF AGE AND SIZE OF CHANNEL CATFISH ON THE INFECTIVITY OF CCV ...3.0006

SUSCEPTIBILITY OF OTHER SPECIES OF CATFISHES TO CCV AND THEIR POSSIBLE ROLE AS CARRIERS ...3.0007

CHANNEL CATFISH VIRUS REPLICATION CURVES IN INTERNAL ORGANS AND ASSOCIATED PATHOLOGY ...3.0010

Lymphocystis

PATHOLOGY RESEARCH ...3.0027

CYTOLOGY OF VIRAL NEOPLASMS OF FISH ...3.0045

Oncogenic

EPIDERMAL PAPILLOMAS ...3.0021

Sockeye Virus

HISTOPATHOLOGY OF SALMONID FISHES - HISTOPATHOGENESIS OF CULTUS LAKE VIRUS DISEASE ...3.0092

RELATIONSHIP OF TEMPERATURE TO DISEASES OF SALMONID FISH ...3.0116

Viruses of Insects

TO CHARACTERIZE PATHOGENS OF MOSQUITOES ...2.0007

BIOLOGICAL CONTROL OF INSECTS AFFECTING MAN ...2.0027

VIRAL PATHOGENS ...2.0035

Inclusion Viruses

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...2.0043

Insect Viruses -nonspecific

BIOLOGY OF MICROORGANISMS OF MOSQUITOES ...2.0022

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS FOR PUBLIC AND MILITARY PROGRAMS ...2.0033

FACTORS AFFECTING THE ROLE OF MICROORGANISMS IN THE BIOLOGICAL CONTROL OF INSECT PESTS ...2.0053

Noninclusion Viruses

BIOLOGY OF MICROORGANISMS OF MOSQUITOES ...2.0022

INSECT RESISTANCE TO, AND THE GENETIC MECHANISM OF CHEMICAL CONTROL AGENTS ...2.0029

Oncogenic

ENTOMOLOGY DEVELOPMENT OF A LIGHTWEIGHT TRAP FOR COLLECTION OF MOSQUITOES FOR VIRUS ISOLATION ...4.0071

Viruses - Plant

BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...2.0121
A CRITICAL TEST OF METHODS FOR ISOLATION OF VIRUSES FOR USE IN CONTROL OF NUISANCE ALGAE ...2.0133
THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER ...4.0004

Vitamins

HISTOPATHOLOGY OF LIVERS OF RAINBOW TROUT FED RANCID PELLETS CONTAINING AFLATOXIN ...3.0081

Ascorbic Acid

EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...3.0089

Carotene

TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005

Thiamine

ATTRACTIVENESS AND REPELLENCY OF MAN TO MOSQUITO BITES ...4.0041

Tocopherol

HISTOPATHOLOGY OF LIVERS OF RAINBOW TROUT FED RANCID PELLETS CONTAINING AFLATOXIN ...3.0081

Volatility of Pesticides

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0002
INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0009
MOVEMENT OF CHLORINATED HYDROCARBON INSECTICIDES IN SOILS ...1.0011
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0013
VOLATILIZATION LOSSES OF PESTICIDES FROM SOILS ...1.0016
REACTIONS OF PESTICIDES WITH SOILS ...1.0020
REACTIONS OF PESTICIDES WITH SOILS IN RELATION TO SOIL PRODUCTIVITY IN THE SOUTHWEST ...1.0021
CHLORINATED PESTICIDES IN THE SOIL-WATER-PLANT SYSTEM AND THEIR MANAGEMENT TO AVOID POLLUTION ...1.0024
THE DISPOSITION OF PESTICIDES IN THE SOIL ...1.0030
PESTICIDES IN SOILS AND WATERS OF THE SOUTHERN PIEDMONT ...1.0033
ROW LENGTH, GRADE AND DRAINAGE REQUIREMENTS OF CROPS ...1.0049
WATER AND SOIL POLLUTION BY FARM CHEMICALS IN THE LOWER MISSISSIPPI DELTA ...1.0050
BEHAVIOR OF PESTICIDES AND POLLUTANTS IN SOIL, WATER, AND PLANTS ...1.0053
CONTROL OF PESTICIDES IN SOIL AND WATER ...1.0054
MULTI-DISCIPLINARY RESEARCH IN POLLUTION ...1.0070
FACTORS INFLUENCING INSECTICIDE RESIDUES IN FOOD, FORAGE AND OIL CROPS, AND SOIL ...1.0077
BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...1.0081
HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...1.0107
OCCURRENCE OF PESTICIDES IN AQUATIC ENVIRONMENTS ...1.0219

Washington

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168
MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...3.0082

Waste Disposal -general

NUTRIENT & WATER INPUTS & OUTGO FROM THE ORGANIC & MINERAL SOILS IN THE LAKE APOPKA AREA ...1.0029
NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...4.0015

Waste Water -other

POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...1.0036
WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...1.0162

Waste Water Treatment

CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0093
DEVELOPMENT OF TREATMENT PROCESS FOR CHLORINATED HYDROCARBON PESTICIDE MANUFACTURING AND PROCESSING WASTES ...1.0118
DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183
CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0210
ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211

Adsorption & Absorption

POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...1.0036

Biochemical Oxygen Demand

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183
DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...1.0184
QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204
MICROBIOLOGY OF FARM PONDS ...1.0220
EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168

Biological Treatment

Activated Sludge

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183

Higher Plants

PHOTOCHEMICAL METHODS FOR PURIFYING WATER ...1.0115

Chemical Oxygen Demand

PHOTOCHEMICAL METHODS FOR PURIFYING WATER ...1.0115
QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204

Chemical Treatment

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183

Pollutant Removal

Organics

DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183

Pesticides

PHOTOCHEMICAL METHODS FOR PURIFYING WATER ...1.0115
DEVELOPMENT OF TREATMENT PROCESS FOR CHLORINATED HYDROCARBON PESTICIDE MANUFACTURING AND PROCESSING WASTES ...1.0118

STUDY OF ELECTROHYDRAULIC WATER TREATMENT ...1.0121
PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166
DEEPWATER PILOT PLANT-ENGINEERING AND INTERCEPTOR FEASIBILITY ...1.0183
CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0210

Radiation Treatment

PHOTOCHEMICAL METHODS FOR PURIFYING WATER ...1.0115

Sewage Testing

POLLUTION EFFECTS ON GROUND WATER RECHARGE IN HAWAII ...1.0036

Sewage Treatment Plant

PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...1.0166

Sludge Disposal

NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...4.0015

Stage of Treatment

Secondary Treatment

DEEPWATER PILOT PLANT ENGINEERING AND INTERCEPTOR FEASIBILITY STUDY ...1.0184

Tertiary Treatment

PHOTOCHEMICAL METHODS FOR PURIFYING WATER ...1.0115

Waste Overflow

STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES ...1.0142

Water Alkalinity

PROPERTIES OF TILE DRAINAGE WATER ...1.0045
QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187
AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...1.0343
EFFECT OF COPPER SULFATE ON AQUATIC WEEDS ...2.0108
PISCICIDE TOXICOLOGY OF THE CYPRINIDS IN EAST AND WEST PAULINA LAKES ...2.0228
THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER ...4.0004
AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...4.0011
REPRODUCTIVE BIOLOGY AND EARLY LIFE HISTORY OF CYPRINIDS IN EAST AND PAULINA LAKES ...4.0083

Water Balance - Budget

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...2.0168

Water Chemistry

SORPTION AND MOVEMENT OF POLLUTED WATER IN SOIL ...1.0012
BEHAVIOR OF POLLUTANTS IN WATER ...1.0022
PROPERTIES OF TILE DRAINAGE WATER ...1.0045
STUDY OF ELECTROHYDRAULIC WATER TREATMENT ...1.0121
ESTUARINE ECOSYSTEMS ...1.0128
EFFECTS OF PESTICIDES ON ESTUARINE PRODUCTIVITY ...1.0133
SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0141
THE FACTOR CONTROLLING THE DYNAMICS OF NON-IONIC SYNTHETIC ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS ...1.0148
DEVELOPMENT OF FIELD METHODS IN SAMPLING WATER FOR PESTICIDE ANALYSIS ...1.0173
GROUND AND SURFACE WATERS - POLLUTION ...1.0182
ELECTROPHORETIC CLARIFICATION OF WATER ...1.0211
SOURCES OF QUALITY IMPAIRMENT OF SURFACE WATERS ...1.0218
ATOMIC ABSORPTION ANALYSIS OF PHOSPHATES IN WATER ...1.0227
CONSTRUCTION OF PESTICIDES DEGRADABLE BY NORMAL MICROFLORA OF NATURAL WATERS AND SOILS ...1.0331
LAKE HURON CHEMICAL CONTROL ...2.0209
OCCURRENCE OF FILAMENTOUS SLIMES ORGANISMS BELOW OUTFALLS ...4.0009
NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE ...4.0025
EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029

Analysis and Detection

ORGANIC SUBSTANCES IN WATER ...1.0119
FLUORESCENT PROBES IN THE DEVELOPMENT OF NEW ANALYTICAL METHODS FOR WATER POLLUTION ...1.0137
RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...1.0146
THE EFFECTS OF HERBICIDES, PESTICIDES, AND FERTILIZERS ON THE OPTICAL PROPERTIES OF WATER ...1.0177
CONCENTRATION AND ANALYSIS OF PESTICIDES AND OTHER RECALCITRANT MOLECULES IN WATER SUPPLIES BY ULTRAFILTRATION ...1.0185
CHROMATOGRAPHIC CONCENTRATION OF PESTICIDES FROM A LARGE MASS OF WATER ...1.0188
CHLORINATED ORGANIC CONTAMINANTS IN THE MILWAUKEE RIVER ...1.0226
ATOMIC ABSORPTION ANALYSIS OF PHOSPHATES IN WATER ...1.0227
THE FATE AND EFFECTS OF PESTICIDES IN THE AQUATIC ENVIRONMENT OF THE FLATHEAD LAKE DRAINAGE AREA ...1.0297
CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER ...2.0290
MARINE PILING ANALYSIS ...2.0296

Oil Removal

MARINE PILING ANALYSIS ...2.0296

Salt

ENZYMES FOR ANALYSIS AND PURIFICATION OF SALINE WATER SYSTEMS ...1.0153
ADSORPTION OF PESTICIDES FROM SEA WATER ...1.0159

Water Depth, Water Levels

WATER MANAGEMENT IN MOSQUITO IMPOUNDMENTS ...2.0064
FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...2.0142
WATERLEVEL MANAGEMENT ON IMPOUNDMENTS OF LOW QUALITY SOILS ...2.0163
EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...2.0171
BIOLOGICAL AND LIMNOLOGICAL INVENTORY OF SEVEN FLOOD CONTROL RESERVOIRS IN THE STATE OF INDIANA ...2.0199
IMPOUNDMENT EFFECTS ON WATER QUALITY AS REFLECTED IN PARASITISM OF RESERVOIR BASSES ...3.0018
SALT WATER POND RESEARCH ...3.0073
POST-IMPROVEMENT LIMNOLOGICAL-ANALYSES AND FISH-POPULATION EVALUATIONS OF CERTAIN STRIP-MINE LAKES IN SOUTHEAST KANSAS ...4.0078

GAME FISH REPRODUCTION AND ROUGH FISH PROBLEMS IN ELEPHANT BUTTE LAKE ...4.0081
LAKE ONTARIO INTERIM COMPREHENSIVE FISHERIES MANAGEMENT PLAN ...4.0082

Water Distribution Systems

INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...2.0106

Water Environment -other

EFFECT OF ENDRIN ON FISH AND THEIR ENVIRONMENT UNDER CONTROLLED CONDITIONS ...1.0230
BIOLOGICAL CONTROL OF MIDGES, GNATS AND MOSQUITOES ...2.0014
BIOLOGY AND WATER MANAGEMENT STUDIES FOR CONTROL OF LOUISIANA MOSQUITOES (RICE FIELDS) ...2.0044
BACTERIAL FLORA OF APPARENTLY HEALTHY STRIPED BASS (ROCCUS SAXATILIS) & ITS CORRELATION WITH THE BACTERIA OF THE HATCHERY WATER SUPPLY ...3.0046
ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...4.0069

Water Light Quality & Quantity

EFFECT OF ENDRIN ON FISH AND THEIR ENVIRONMENT UNDER CONTROLLED CONDITIONS ...1.0230
PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...1.0236
ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...1.0326
BIOLOGICAL AND BIOCHEMICAL FACTORS INFLUENCING THE DEVELOPMENT OF LARVAL MOSQUITO POPULATIONS ...2.0052
AQUATIC WEED CONTROL RESEARCH ...2.0100
BIOASSAY ...2.0211
RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY ...4.0002
BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...4.0012
THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0014
ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024

Water Management

QUALITY OF IRRIGATION RETURN FLOW ...1.0102
UPPER ST. JOHNS RIVER BASIN WATER QUALITY, FLORIDA ...1.0134
FARM FISH POND MANAGEMENT ...1.0340
COORDINATION OF MOSQUITO CONTROL IN NEW JERSEY ...2.0061
EVALUATION OF MANAGEMENT PRACTICES ON THE STATE-OWNED WILDLIFE AREAS ...2.0103
HAUL SEINE STUDY ...2.0192
EXPERIMENTAL ESTABLISHMENT OF MONOSPECIFIC WALLEYE POPULATIONS AS A MANAGEMENT MEASURE FOR SMALL WARMWATER LAKES IN NORTHERN MINNESOTA ...2.0214
UTILIZATION AND MANAGEMENT OF COASTAL MARSHES AND RESOURCES ...3.0029

Water Movement, Velocity

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039
PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...1.0236
BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342
ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0117
CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...2.0154
EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...2.0171
EFFECTS OF WATER EXCHANGE AND BLUE CRAB CONTROL ON SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IMPOUNDMENTS ...2.0275
DISEASES OF FISH ...3.0025
ETIOLOGY OF ESTUARINE FISH DISEASES ...3.0040
RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT FINGERLINGS TO FURUNCULOSIS ...3.0041
RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY ...4.0002
EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029

Water Pollution

FATE OF HARMFUL METALS IN SOIL AND WATER SYSTEMS ...1.0003
PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...1.0034
REDUCTION OF HAZARDS ASSOCIATED WITH RESIDUES OF INSECTICIDAL CHEMICALS IN THE ENVIRONMENT ...1.0037
PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039
INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0116
AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117
EFFECTIVENESS OF IODINE FOR DISINFECTION OF PUBLIC WATER SUPPLIES & TO DETERMINE PHYSIOLOGICAL EFFECTS ON A HUMAN POPULATION ...1.0126
PESTICIDE KINETICS ...1.0127
ESTUARINE ECOSYSTEMS ...1.0128
CHEMICAL ANALYSES ...1.0129
RURAL RUNOFF CONTROL ...1.0135
STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES ...1.0142
THE FATE OF SELECT PESTICIDES IN THE AQUATIC ENVIRONMENT ...1.0144
PESTICIDE RESIDUES IN KANSAS STREAMS ...1.0150
MONITORING OF PESTICIDE LEVELS IN THE GREAT LAKES ...1.0160
PESTICIDE MONITORING OF AQUATIC ENVIRONMENT, MICHIGAN PORTION OF THE GREAT LAKES BASIN ...1.0163
PRESTICIDE INPUTS AND LEVELS IN MINNESOTA WATERS OF THE LAKE SUPERIOR BASIN ...1.0167
A TISSUE ENZYME ASSAY FOR CHLORINATED HYDROCARBON INSECTICIDES ...1.0168
MAYFLY DISTRIBUTION AS A WATER QUALITY INDEX ...1.0169
CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...1.0191
TRANSFER OF PESTICIDES THROUGH SOILS, WATER, SEDIMENTS AND AQUATIC LIFE ...1.0202
EFFECTS OF WATER POLLUTION ON ZOOPLANKTON ...1.0207
CHARACTERISTICS AND POLLUTIONAL PROBLEMS OF PESTICIDE MANUFACTURING WASTES ...1.0210
PESTICIDES AND MICROBIAL ECOLOGY OF LAKE CHAMPLAIN ...1.0213
TERMINAL RESIDUES OF CHLORINATED HYDROCARBON PESTICIDES IN LAKE MICHIGAN AND ASSOCIATED TRIBUTARIES ...1.0222
EFFECT OF ENDRIN ON FISH AND THEIR ENVIRONMENT UNDER CONTROLLED CONDITIONS ...1.0230

PRELIMINARY STUDIES ON ENDRIN AND OTHER PESTICIDE UPTAKES BY FINGERLING CHANNEL CATFISH ...1.0231

PESTICIDES RESEARCH ...1.0232

EFFECTS OF PESTICIDES ON AQUATIC ANIMALS IN THE ESTUARINE AND MARINE ENVIRONMENTS ...1.0234

PHYSIOLOGY AND BEHAVIOR OF LARVAE (PHYSIOECOLOGY OF SHELLFISH PROGRAM) ...1.0236

RESEARCH STUDY ON THE EFFECTS OF POLLUTION ON SUB-TROPICAL FISH AND CRUSTACEANS ...1.0237

ENZYME SYSTEMS OF ESTUARINE ORGANISMS ...1.0239

LABORATORY BIOASSAYS ...1.0241

PHYSIOLOGY OF ESTUARINE ORGANISMS ...1.0242

CONTAMINATION OF CHANNEL CATFISH WITH DIELDRIN FROM AGRICULTURAL RUNOFF ...1.0247

ENZYME AND TISSUE ALTERATIONS IN FISH - A MEASURE OF WATER QUALITY ...1.0248

PESTICIDE CONTAMINATION OF ENVIRONMENT ...1.0250

TOXICITY OF POLLUTANTS TO STRIPED BASS ...1.0251

THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...1.0253

RATES OF PESTICIDE BUILDUP IN SALMONIDS RECENTLY INTRODUCED IN THE GREAT LAKES ...1.0256

LONG-TERM EFFECTS OF PESTICIDES ON AQUATIC INVERTEBRATES ...1.0258

PHYSIOLOGIC RESPONSE OF AQUATIC ORGANISMS TO POLLUTANTS ...1.0260

TOXICITY OF SELECTED METALS TO CONDITIONED FISH ...1.0302

BIOCHEMICAL EFFECTS OF TOXIC CHEMICALS ...1.0303

EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - ORGANOCHLORINE PESTICIDES AND DISEASE RESISTANCE MECHANISMS OF RAINBOW TROUT ...1.0312

FISHERY RESOURCES PROGRAM ...1.0317

ALGAL FOODS OF SHELLFISH (MICROORGANISMS AFFECTING SHELLFISH PROGRAM) ...1.0326

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...1.0328

STUDY OF CHRONIC TOXICITY OF LINDANE TO SELECTED FRESHWATER FISHES AND FOOD CHAIN ORGANISMS ...1.0337

FARM FISH POND MANAGEMENT ...1.0340

BIOCHEMICAL ECOLOGICAL RELATIONSHIPS OF PESTICIDES AND THE BIO-CONSTITUENTS OF AQUATIC COMMUNITIES ...1.0342

RESPIRATION RATES OF FISH-FOOD INVERTEBRATES EXPOSED TO PESTICIDES ...1.0355

ENVIRONMENTAL TOXICOLOGY OF PESTICIDES ...1.0361

CHEMICAL BIOCIDES IN LAKES ...1.0364

THE EFFECT OF PESTICIDES ON AN ECOSYSTEM ...1.0365

PESTICIDE LEVELS IN BIRDS WINTERING ON LAKE MICHIGAN ...1.0367

BIOLOGY AND CONTROL OF PASTURE MOSQUITOES ...2.0008

AQUATIC PLANT CONTROL ...2.0128

THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...2.0150

RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...2.0161

INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...2.0167

TRIBUTARY SURVEY OF LAKES ONTARIO AND ERIE ...2.0220

SWIMMER'S ITCH - INTERMEDIATE HOST, DISTRIBUTION AND ECOLOGY ...2.0279

CORRELATION OF STRUCTURE VS. ACTIVITY OF POLLUTANTS OF FRESH WATER ...2.0290

COOPERATIVE FISH PARASITE AND DISEASE STUDY ...3.0015

DISEASES OF FISH ...3.0025

ETIOLOGY OF ESTUARINE FISH DISEASES ...3.0040

THE EFFECTS OF DIFFERENTLY EXTRACTED ENDOTOXINS FROM ESCHERICHIA COLI ON RAINBOW TROUT (SALMO GAIRDNERI) ...3.0071

EFFECT OF ENVIRONMENTAL POLLUTION ON FISH DISEASES - EFFECT OF HEAT STRESS ON DISEASE RESISTANCE MECHANISMS IN SALMONID FISHES ...3.0089

INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...4.0001

RELATIVE LEACHING RATES OF COMMON NITROGEN CARRIERS FROM SANDY SOILS IN RELATION TO LAKE EUTROPHICATION ...4.0006

NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...4.0015

PHYTOPLANKTON NUTRITION AND PHOTOSYNTHESIS IN EUTROPHIC LAKES ...4.0016

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...4.0018

RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...4.0019

NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE ...4.0025

INFLUENCE OF SUSPENDED MICROSCOPIC SUBSTANCES ON THE METABOLISM OF MICROORGANISMS RESPONSIBLE FOR BIOLOGICAL ENRICHMENT OF WATER ...4.0027

AQUATIC PLANTS OF POLLUTED WATERS IN SOUTHWESTERN UNITED STATES ...4.0028

Water Pressure

EFFECT OF SUPERSATURATION OF DISSOLVED NITROGEN ON MIGRATING SALMONIDS ...3.0083

Water Quality -general

INTERACTION OF FERTILIZERS WITH PESTICIDES AS RELATED TO WATER QUALITY IN SOILS ...1.0008

PROPERTIES OF TILE DRAINAGE WATER ...1.0045

SOILS, PESTICIDES AND THE QUALITY OF WATER ...1.0065

INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0116

AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...1.0117

QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...1.0187

QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...1.0204

CHEMICAL, PHYSICAL, AND BIOLOGICAL DYNAMICS OF NORTHERN PRAIRIE LAKES ...1.0205

INVESTIGATION OF RICE IRRIGATION RETURN FLOWS - TEXAS COASTAL PRAIRIE REGION ...1.0209

DISTRIBUTION OF ORGANOPHOSPHORUS PESTICIDE RESIDUES IN NATURAL WATERS AND SEDIMENTS ...1.0215

ARTIFICIAL SUBSTRATE SAMPLERS AS INDICATORS OF WATER QUALITY ...1.0225

THE INFLUENCES OF ENVIRONMENTAL CONDITIONS ON THE TOXICITY OF PESTICIDES ...1.0278

AQUATIC PEST CONTROL ...2.0112

SURVEY OF POND WEEDS AND PLANT SUCCESSION ...2.0127

THE EFFICACY OF NEW FORMULATIONS OF ANTIMYCIN IN NATURAL LAKES AND STREAMS ...2.0246

LIMNOLOGICAL, ICHTHYOLOGICAL, AND PARASITOLOGICAL INVESTIGATIONS ON ARKANSAS RESERVOIRS IN RELATION TO WATER QUALITY ...3.0019

RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY ...4.0002

A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...4.0018

RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...4.0019

ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...4.0069

Water Quality Control-general

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...**1.0032**

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...**1.0052**

QUALITY OF IRRIGATION RETURN FLOW ...**1.0102**

EVALUATION AND DEMONSTRATION OF IRRIGATION METHODS AND PRACTICES TO REDUCE CONTAMINATION IN IRRIGATION WASTE WATER ...**1.0104**

GREEN BAY RESEARCH PROGRAM ...**1.0112**

STUDY OF METHODS FOR REDUCING WATER POLLUTION FROM STORM SEWER AND COMBINATION DISCHARGES THROUGH DEFINED PUBLIC WORKS PRACTICES ...**1.0142**

RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...**1.0146**

EVALUATION OF PESTICIDE SOURCES AND LEVELS TRIBUTARY TO LAKES MICHIGAN AND SUPERIOR ...**1.0221**

ARTIFICIAL SUBSTRATE SAMPLERS AS INDICATORS OF WATER QUALITY ...**1.0225**

EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...**2.0165**

EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...**2.0168**

EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...**2.0170**

EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...**2.0171**

IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...**2.0181**

CHANGES IN WATER ENVIRONMENT RESULTING FROM AQUATIC PLANT CONTROL ...**2.0183**

AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...**4.0011**

WATER QUALITY REQUIREMENTS OF AQUATIC INSECTS ...**4.0066**

MUCUS & FRESHWATER OSMOREGULATION IN ANADROMOUS FISHES & RELATIONSHIPS TO MORTALITIES IN THE ALEWIFE ...**3.0106**

CONTROL OF VIBRIOSIS IN SALMON ...**3.0117**

EXPERIMENTAL REARING OF SALMON AND STEELHEAD IN BRACKISH WATER IMPOUNDMENTS ...**3.0119**

BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...**4.0012**

ANATOMICAL, PHYSIOLOGICAL AND ECOLOGICAL STUDIES ON MYRIOPHYLLUM SPICATIU ...**4.0013**

Water Reuse

QUALITY OF IRRIGATION RETURN FLOW ...**1.0102**

INVESTIGATION OF RICE IRRIGATION RETURN FLOWS - TEXAS COASTAL PRAIRIE REGION ...**1.0209**

ALGACIDES FOR USE IN WATER RECLAMATION AND REUSE SYSTEMS ...**2.0177**

Water Salinity

PREDICTING MINERAL QUALITY OF RETURN FLOW WATER ...**1.0122**

ADSORPTION OF PESTICIDES FROM SEA WATER ...**1.0159**

RESEARCH STUDY ON THE EFFECTS OF POLLUTION ON SUB-TROPICAL FISH AND CRUSTACEANS ...**1.0237**

BEHAVIOR OF ESTUARINE ANIMALS ...**1.0240**

ECOLOGICAL STUDIES OF WILDLIFE MANAGEMENT PRACTICES ...**1.0327**

BIOLOGY AND CONTROL OF MOSQUITOES, SAND FLIES, AND GNATS OF U.S. COAST ...**2.0043**

INFLUENCE OF PESTICIDES & OTHER HYDROCARBONS ON GROWTH OF EURYTOLERANT MICROALGAE ...**2.0148**

NATURAL HISTORY OF PREDATORS AND COMPETITORS (PREDATOR CONTROL PROGRAM) ...**2.0271**

EXPERIMENTS TO RE-ESTABLISH HISTORICAL OYSTER SEED GROUNDS AND TO CONTROL THE SOUTHERN OYSTER DRILL ...**2.0274**

OYSTER DISEASE MORTALITY ALONG THE CALIFORNIA COAST ...**3.0022**

SHELLFISH MORTALITY - CHESAPEAKE BAY ...**3.0033**

ETIOLOGY OF ESTUARINE FISH DISEASES ...**3.0040**

AQUICULTURE, SALMON CULTURE - RESEARCH ...**3.0053**

MASS MORTALITY OF OYSTERS ALONG THE OREGON COAST ...**3.0060**

SALT WATER POND RESEARCH ...**3.0073**

MASS MORTALITY OF PACIFIC OYSTERS ALONG THE WASHINGTON COAST ...**3.0082**

Water Standards & Baselines

INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...**1.0116**

AN INVESTIGATION INTO RECREATIONAL WATER QUALITY CRITERIA ...**1.0117**

PREDICTING MINERAL QUALITY OF RETURN FLOW WATER ...**1.0122**

PESTICIDE KINETICS ...**1.0127**

RESEARCH INITIATION - FATE OF SELECTED ORGANOPHOSPHATE AND CARBAMATE INSECTICIDES IN SURFACE WATERS ...**1.0146**

THE FACTOR CONTROLLING THE DYNAMICS OF NONIONIC SYNTHETIC ORGANIC CHEMICALS IN AQUATIC ENVIRONMENTS ...**1.0148**

A STUDY PROGRAM TO IDENTIFY PROBLEMS RELATED TO OCEANIC ENVIRONMENTAL QUALITY - NORTH ATLANTIC ...**1.0158**

SERVICES FOR THE QUANTITATIVE ANALYSIS OF PESTICIDES IN SEAWATER AND BIOLOGICAL SAMPLES ...**1.0172**

PESTICIDE MONITORING PROGRAM LAKE MICHIGAN AND TRIBUTARIES IN ILLINOIS ...**1.0328**

DISTRIBUTION AND METABOLIC FATE OF INDUSTRIAL POLLUTANTS AND PESTICIDES IN A MODEL AQUATIC ECOSYSTEM ...**1.0333**

HERBICIDE RESIDUES ...**2.0109**

LAKE SUPERIOR PERIPHYTON IN RELATION TO WATER QUALITY ...**4.0017**

Water Table

ENVIRONMENTAL BIOLOGY - BIOGEOCHEMICAL CYCLING IN ECOLOGICAL SYSTEMS ...**1.0068**

SOIL PHYSICAL PROPERTIES AND SOIL WATER MOVEMENT ...**1.0072**

NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...**4.0015**

Water Wells

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE SOUTHEAST ...**1.0032**

PESTICIDE POLLUTION OF FARMSTEAD WATER SUPPLIES IN THE NORTHEAST ...**1.0052**

MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...**1.0071**

FATE OF POLLUTANTS IN GROUND WATER ...**1.0079**

PRINCIPLES, FACILITIES AND SYSTEMS FOR GROUND WATER RECHARGE--SOUTHERN PLAINS ...**1.0094**

GROUND AND SURFACE WATERS - POLLUTION ...**1.0182**

CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...**1.0189**

PESTICIDE LEVELS IN WATER AND WILDLIFE OF REELFOOT LAKE, TENNESSEE ...**1.0208**

Water Yield

WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...**1.0005**

EFFECT OF USING RUNOFF WATER IN RECHARGE WELLS-HIGH PLAINS AREA ...**1.0100**

Watersheds

EFFECT OF PESTICIDE RESIDUES AND OTHER ORGANO-TOXICANTS ON THE QUALITY OF SURFACE AND GROUNDWATER RESOURCES ...**1.0041**

PESTICIDE MONITORING PROGRAM ...**1.0156**

MASSACHUSETTS PESTICIDE MONITORING STUDY ...**1.0157**

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...**1.0161**

WATERSHED ANALYSIS RELATING TO EUTROPHICATION OF LAKE MICHIGAN ...**1.0162**

PESTICIDES INPUTS AND LEVELS IN MINNESOTA WATERS OF LAKE SUPERIOR BASIN ...**1.0166**

QUALITY OF STORM WATER DRAINAGE FROM URBAN LAND AREAS IN NORTH CAROLINA ...**1.0187**

TRANSFER OF PESTICIDES THROUGH WATER, SEDIMENTS, AND AQUATIC LIFE ...**1.0201**

TRANSFER OF PESTICIDES THROUGH SOILS, WATER, SEDIMENTS AND AQUATIC LIFE ...**1.0202**

Agricultural Watersheds

PESTICIDE MOBILITY AND DEGRADATION IN SOIL-WATER SYSTEMS ...**1.0013**

NUTRIENT AND WATER INPUTS AND OUTGO FROM THE ORGANIC AND MINERAL SOILS IN THE LAKE APOPKA AREA ...**1.0027**

PROPERTIES OF TILE DRAINAGE WATER ...**1.0045**

REMOVAL OF CONTAMINANTS FROM RURAL WATER SUPPLIES ...**1.0047**

CHEMICAL CONTAMINANTS IN SOIL AND WATER RUNOFF IN NEW ENGLAND ...**1.0051**

MOVEMENT OF HERBICIDES OFF, INTO AND THROUGH SOILS ...**1.0071**

NITROGEN, PHOSPHORUS, HERBICIDE MOVEMENT BY SOIL WATER AND SOURCES OF CONTAMINATION ...**1.0073**

EFFECTS OF VEGETATIVE COVERS UPON RUNOFF FROM PRINCIPAL SOILS OF WESTERN NORTH CAROLINA ...**1.0074**

EFFECT OF PESTICIDES ON THE QUALITY OF SURFACE AND GROUND WATERS IN THE WESTERN GULF REGION ...**1.0101**

POLLUTION LOADS IN RUNOFF FROM SMALL AGRICULTURAL WATERSHEDS ...**1.0154**

AN ECOLOGICAL EVALUATION OF STREAM EUTROPHICATION ...**1.0161**

PHYSICAL AND CHEMICAL PROPERTIES OF SEDIMENTS ...**1.0170**

GROUND AND SURFACE WATERS - POLLUTION ...**1.0182**

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...**1.0191**

CHEMICAL AND SEDIMENT MOVEMENT FROM AGRICULTURAL LAND INTO LAKE ERIE ...**1.0192**

QUANTIFICATION OF POLLUTANTS IN AGRICULTURAL RUNOFF ...**1.0204**

SOURCES OF QUALITY IMPAIRMENT OF SURFACE WATERS ...**1.0218**

THE INFLUENCE OF HERBICIDES USED ON HORTICULTURAL CROPS ON STREAM ECOLOGY ...**2.0150**

Forest Watersheds

AN EVALUATION OF THE INSECTICIDE 'SEVIN' AS A WATERSHED POLLUTANT ...**1.0067**

BEHAVIOR OF CHEMICALS INTRODUCED INTO THE FOREST ENVIRONMENT AND THEIR IMPACT ON THE ECOSYSTEM ...**1.0083**

COORDINATION OF MOSQUITO CONTROL IN NEW JERSEY ...**2.0061**

Small Watersheds

WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...**1.0005**

EFFECT OF AGRICULTURAL CHEMICALS ON THE QUALITY OF GROUND AND SURFACE WATERS ...**1.0080**

MOVEMENT OF INSECTICIDES IN SOIL AND WATER ...**1.0098**

POLLUTION LOADS IN RUNOFF FROM SMALL AGRICULTURAL WATERSHEDS ...**1.0154**

Wax, Paraffin

EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...**2.0267**

Weather - Physical Properties

ATMOSPHERIC CONSTITUENTS OF THE TERRESTRIAL-TYPE PLANETS ...**4.0007**

Energy-radiation

Temperature

REDUCTION OF PESTICIDE RESIDUE HAZARDS ...**1.0040**

Humidity - Water Vapor

REDUCTION OF PESTICIDE RESIDUE HAZARDS ...**1.0040**

Weed Control By . . .

Biocontrol

AQUATIC PLANT CONTROL BY HERBIVOROUS AMUR FISH ...**2.0092**

CHEMICAL CONTROL OF WEEDS IN PONDS ...**2.0093**

SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...**2.0095**

BIOLOGICAL CONTROL OF WEEDS ...**2.0099**

CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...**2.0101**

BIOLOGICAL CONTROL OF WEEDS ...**2.0102**

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...**2.0104**

ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0117**

SOUTHEASTERN BIOLOGICAL CONTROL OF WEEDS INVESTIGATIONS ...**2.0120**

BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...**2.0121**

BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...**2.0122**

MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...**2.0124**

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0129**

THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...**2.0130**

EXPERIMENTAL INTRODUCTION OF EXOTIC FRESHWATER FISHES ...**2.0131**

AQUATIC WEED SUPPRESSION AND CONTROL IN LARGE CANALS ...**2.0132**

A CRITICAL TEST OF METHODS FOR ISOLATION OF VIRUSES FOR USE IN CONTROL OF NUISANCE ALGAE ...**2.0133**

NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...**2.0135**

AQUATIC WEED CONTROL BY POND FISHES ...**2.0139**

INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...**2.0144**

INSECTS ASSOCIATED WITH AQUATIC WEED PESTS OF FOREIGN ORIGIN ...**2.0145**

CONTROL OF EURASIAN MILFOIL ...**2.0156**

CONTROL AND UTILIZATION OF AQUATIC PLANTS ...**2.0157**

CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...**2.0160**

BIOLOGICAL CONTROL - TAMARISK AND OTHER PHREATOPHYTES ...**2.0164**

EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...**2.0170**

NATURAL ENEMIES OF EURASIAN WATERMILFOIL IN PAKISTAN ...**2.0173**

THE CRAYFISH (ORCONECTES CAUSEYI) AS A BIOLOGICAL CONTROL OF AQUATIC VEGETATION ...**2.0175**

LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...**2.0184**

METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...**2.0186**

NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...**2.0188**

AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO ...**2.0227**

BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...**2.0269**

THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER ...**4.0004**

BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...**4.0012**

THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0014**

Chemcontrol

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0002**

CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...**1.0004**

WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...**1.0005**

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0009**

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...**1.0010**

INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...**1.0015**

RESPROUTING OF CHAPARRAL ...**1.0017**

CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...**1.0025**

DISPOSITION OF PESTICIDES IN THE SOIL ...**1.0031**

HERBICIDE EQUILIBRIA OF LATOSOLIC SOIL ...**1.0035**

PESTICIDAL RESIDUES OF AGRICULTURAL CHEMICALS ...**1.0063**

FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...**1.0089**

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...**1.0091**

PERSISTENCE AND MODES OF HERBICIDE DISSIPATION UNDER RANGELAND CONDITIONS ...**1.0096**

QUALITY OF IRRIGATION RETURN FLOW ...**1.0102**

HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...**1.0107**

COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...**1.0125**

COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...**1.0145**

CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...**1.0189**

DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...**1.0196**

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...**1.0228**

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...**1.0319**

FATE OF AQUATIC HERBICIDES IN THE AQUATIC ENVIRONMENT ...**1.0329**

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...**1.0334**

FARM FISH POND MANAGEMENT ...**1.0340**

AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...**1.0343**

CHEMICAL CONTROL OF WEEDS IN PONDS ...**2.0093**

WEED CONTROL IN RICE PRODUCTION ...**2.0097**

WEED CONTROL IN RICE PRODUCTION ...**2.0098**

AQUATIC WEED CONTROL RESEARCH ...**2.0100**

CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...**2.0101**

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...**2.0104**

PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...**2.0105**

AROMATIC SOLVENT AQUATIC HERBICIDES AND EMULSIFYING AGENT TESTING ...**2.0107**

EFFECT OF COPPER SULFATE ON AQUATIC WEEDS ...**2.0108**

HERBICIDE RESIDUES ...**2.0109**

GROWTH SUPPRESSION AND REDUCTION IN REGROWTH POTENTIAL OF AQUATIC WEEDS ...**2.0110**

LABORATORY STUDY OF AQUATIC ENVIRONMENTAL FACTORS AND PLANT GROWTH STAGES ON AQUATIC WEED GROWTH AND HERBICIDAL RESPONSE ...**2.0111**

CONTROL OF AQUATIC WEEDS ...**2.0113**

CHEMICAL CONTROL OF DITCHBANK WEEDS IN PEAT AND SANDY SOIL AREAS OF SOUTH FLORIDA ...**2.0114**

BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0115**

EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...**2.0116**

ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0117**

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0118**

WEED CONTROL IN CITRICULTURE ...**2.0123**

TESTING OF NEW HERBICIDES ...**2.0125**

TESTING OF METHODS OF HERBICIDE APPLICATION ...**2.0126**

AQUATIC PLANT CONTROL ...**2.0128**

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0129**

AQUATIC WEED SUPPRESSION AND CONTROL IN LARGE CANALS ...**2.0132**

GROWTH REGULATORS AND MINERAL NUTRITION IN AQUATIC PLANT CONTROL ...**2.0134**

DETERMINATION OF THE EFFECTS OF A FERTILIZER-INDUCED PLANKTON TURBIDITY, SUPPLEMENTED BY HERBICIDES, ON SUBMERGED AQUATIC PLANTS ...**2.0137**

USE OF CHEMICALS ON RICE ...**2.0140**

FOREST AND FARM GAME HABITAT; FISH POND ...**2.0143**

EXPANDED AQUATIC PLANT CONTROL PROJECT ...**2.0146**

AQUATIC PLANT CONTROL - EQUIPMENT FOR MECHANICAL AND CHEMICAL DESTRUCTION ...**2.0147**

DEVELOP A SELECTIVE ALGACIDE TO CONTROL NUISANCE ALGAL GROWTH ...**2.0151**

EVALUATION OF POND CONDITIONS FOLLOWING FERTILIZATION ...**2.0153**

CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...**2.0154**

CONTROL OF UNDESIRABLE AQUATIC VEGETATION ...**2.0155**

CONTROL OF EURASIAN MILFOIL ...**2.0156**

CONTROL OF CANADA THISTLE AND WATER WEEDS ...**2.0158**

STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...**2.0159**

CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...**2.0160**

RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...**2.0161**

BIOLOGY AND CONTROL OF AQUATIC WEEDS ...**2.0162**

WATERLEVEL MANAGEMENT ON IMPOUNDMENTS OF LOW QUALITY SOILS ...**2.0163**

FACTORS CONTROLLING THE GROWTH OF THE AQUATIC WEED SALVINIA ...**2.0166**

INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...**2.0167**

WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...**2.0176**

CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...**2.0178**

LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...**2.0184**

CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...**2.0185**

METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...**2.0186**
CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...**2.0187**
LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...**4.0010**
THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0020**

Control Methods -nonspecific

DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...**2.0094**
EVALUATION OF MANAGEMENT PRACTICES ON THE STATE-OWNED WILDLIFE AREAS ...**2.0103**

Cultural Control

COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...**1.0145**
AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...**1.0343**
DETERMINATION OF THE EFFECTS OF A FERTILIZER-INDUCED PLANKTON TURBIDITY, SUPPLEMENTED BY HERBICIDES, ON SUBMERGED AQUATIC PLANTS ...**2.0137**
EVALUATION OF POND CONDITIONS FOLLOWING FERTILIZATION ...**2.0153**
WATERLEVEL MANAGEMENT ON IMPOUNDMENTS OF LOW QUALITY SOILS ...**2.0163**
EUTROPHICATION - EFFECT OF WEED HARVESTING ...**2.0169**
EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...**2.0170**
EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...**2.0171**
THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...**2.0174**
WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...**2.0176**
EUTROPHICATION OF IOWA LAKES AND STREAMS ...**4.0008**
LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...**4.0010**
TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ...**4.0030**

Integrated Control Measures

FOREST AND FARM GAME HABITAT; FISH POND ...**2.0143**

Physical Control

CONTROL OF AQUATIC WEEDS BY USE OF N2-CO2-HE LASER SYSTEMS ...**2.0091**
EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...**2.0096**
WEED CONTROL IN RICE PRODUCTION ...**2.0097**
WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...**2.0104**
THE USE OF FLAME FOR CONTROLLING WEEDS AND BRUSH ...**2.0136**
AQUATIC PLANT CONTROL - EQUIPMENT FOR MECHANICAL AND CHEMICAL DESTRUCTION ...**2.0147**
ALGAE CONTROL BY ARTIFICIAL MIXING IN LAKE COCHITUATE ...**2.0149**
ALLEVIATION OF LAKE POLLUTION BY UTILIZATION OF AQUATIC PLANTS FOR NUTRITIONAL, MEDICINAL OR INDUSTRIAL PURPOSES ...**2.0152**
EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...**2.0168**
WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...**2.0176**
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...**2.0178**
IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...**2.0181**
IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION ...**2.0182**
CHANGES IN WATER ENVIRONMENT RESULTING FROM AQUATIC PLANT CONTROL ...**2.0183**
NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...**4.0015**
ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0024**

Weed Control of . . .

Aquatic Plants

Algae

PESTICIDE RESIDUES ON ARIZONA CROPS ...**1.0007**
CHEMICAL CONTROL OF WEEDS IN PONDS ...**2.0093**
DYNAMICS OF ALGAE POPULATIONS IN FARM FISH PONDS ...**2.0094**
INVESTIGATIONS OF ALGAE INHIBITING MATERIALS ...**2.0106**
EFFECT OF COPPER SULFATE ON AQUATIC WEEDS ...**2.0108**
AQUATIC PEST CONTROL ...**2.0112**
A CRITICAL TEST OF METHODS FOR ISOLATION OF VIRUSES FOR USE IN CONTROL OF NUISANCE ALGAE ...**2.0133**
A STUDY OF INHIBITORY COMPOUNDS PRODUCED BY FRESH-WATER ALGAE ...**2.0138**
AQUATIC WEED CONTROL BY POND FISHES ...**2.0139**
INFLUENCE OF PESTICIDES & OTHER HYDROCARBONS ON GROWTH OF EURYTOLERANT MICROALGAE ...**2.0148**
ALGAE CONTROL BY ARTIFICIAL MIXING IN LAKE COCHITUATE ...**2.0149**
DEVELOP A SELECTIVE ALGACIDE TO CONTROL NUISANCE ALGAL GROWTH ...**2.0151**
EVALUATION OF POND CONDITIONS FOLLOWING FERTILIZATION ...**2.0153**
EVALUATION OF SOME ENVIRONMENTAL CONDITIONS CAUSING ALGAL BLOOMS ...**2.0165**
EUTROPHICATION - EFFECT OF FLOW AUGMENTATION ...**2.0168**
EUTROPHICATION - BIOLOGICAL CONTROL USING GRAZERS ...**2.0170**
EUTROPHICATION - PHYSICAL ECOLOGICAL CONTROL ...**2.0171**
EUTROPHICATION - PILOT OPERATIONS ...**2.0172**
THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...**2.0174**
ALGACIDES FOR USE IN WATER RECLAMATION AND REUSE SYSTEMS ...**2.0177**
NUISANCE ALGAL GROWTH RELATED TO ENVIRONMENTAL FACTORS ...**2.0180**
LYSIS OF BLUE-GREEN ALGAE BY BACTERIAL ENZYMES AND THEIR POSSIBLE USE IN CONTROLLING ALGAL BLOOMS ...**2.0184**
RESEARCH IN LIMNOLOGY - INTERRELATIONS OF HYDROLOGY AND AQUATIC ECOLOGY ...**4.0002**
FIELD INVESTIGATION OF THE SUBMERSED AQUATIC ENVIRONMENT ...**4.0003**
THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER ...**4.0004**
EUTROPHICATION OF IOWA LAKES AND STREAMS ...**4.0008**
OCCURRENCE OF FILAMENTOUS SLIMES ORGANISMS BELOW OUTFALLS ...**4.0009**
AN INVESTIGATION OF THE CAUSES, EFFECTS, AND CONTROL OF EUTROPHICATION IN MAINE LAKES ...**4.0011**
NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...**4.0015**
PHYTOPLANKTON NUTRITION AND PHOTOSYNTHESIS IN EUTROPHIC LAKES ...**4.0016**
A STUDY OF ALGAL POPULATIONS ASSOCIATED WITH DIFFERENT LEVELS OF WATER QUALITY IN NEW HAMPSHIRE ...**4.0018**
RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...**4.0019**

A PROPOSAL TO STUDY PHOSPHATE INDUCED ALGAL GROWTH IN ORDER TO SUPPRESS OR ELIMINATE THIS PHENOMENA ...**4.0021**

STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...**4.0022**

EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...**4.0023**

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0024**

Aquatic Vegetation -ns

IMPROVING WATER QUALITY BY REMOVAL OF PESTICIDE POLLUTANTS WITH AQUATIC PLANTS ...**1.0216**

FATE OF AQUATIC HERBICIDES IN THE AQUATIC ENVIRONMENT ...**1.0329**

FARM FISH POND MANAGEMENT ...**1.0340**

DETERMINATION OF DIGESTION RATES FOR TROUT ...**1.0346**

CONTROL OF WEEDS AND CERTAIN OTHER AQUATIC PESTS IN THE PACIFIC SOUTHWEST ...**2.0101**

EFFECT OF COPPER SULFATE ON AQUATIC WEEDS ...**2.0108**

BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...**2.0121**

BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...**2.0122**

TESTING OF NEW HERBICIDES ...**2.0125**

TESTING OF METHODS OF HERBICIDE APPLICATION ...**2.0126**

SURVEY OF POND WEEDS AND PLANT SUCCESSION ...**2.0127**

EXPERIMENTAL INTRODUCTION OF EXOTIC FRESHWATER FISHES ...**2.0131**

AQUATIC WEED SUPPRESSION AND CONTROL IN LARGE CANALS ...**2.0132**

USE OF CHEMICALS ON RICE ...**2.0140**

FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...**2.0142**

AQUATIC PLANT CONTROL - EQUIPMENT FOR MECHANICAL AND CHEMICAL DESTRUCTION ...**2.0147**

ALLEVIATION OF LAKE POLLUTION BY UTILIZATION OF AQUATIC PLANTS FOR NUTRITIONAL, MEDICINAL OR INDUSTRIAL PURPOSES ...**2.0152**

CONTROL AND UTILIZATION OF AQUATIC PLANTS ...**2.0157**

THE CRAYFISH (ORCONECTES CAUSEYI) AS A BIOLOGICAL CONTROL OF AQUATIC VEGETATION ...**2.0175**

WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...**2.0179**

IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION ...**2.0182**

AN EVALUATION OF TECHNIQUES TO MANAGE SMALL IMPOUNDMENTS IN OHIO ...**2.0227**

RELATIVE LEACHING RATES OF COMMON NITROGEN CARRIERS FROM SANDY SOILS IN RELATION TO LAKE EUTROPHICATION ...**4.0006**

AQUATIC PLANTS OF POLLUTED WATERS IN SOUTHWESTERN UNITED STATES ...**4.0028**

ECOLOGICAL PARAMETERS OF THE DEVELOPMENT AND FEEDING HABITS OF SIMULIUM SPP. (BLACK FLIES) ...**4.0069**

Vascular Plants

PESTICIDE RESIDUES ON ARIZONA CROPS ...**1.0007**

QUALITY OF IRRIGATION RETURN FLOW ...**1.0102**

COOPERATIVE HERBICIDE MONITORING STUDY IN IRRIGATION SYSTEMS ...**1.0125**

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...**1.0228**

EFFECT OF HERBICIDES ON AN AQUATIC ENVIRONMENT ...**1.0319**

AN EVALUATION OF WIDELY USED HERBICIDES ON AQUATIC PLANTS, FISH AND FISH-FOOD ORGANISMS ...**1.0343**

CONTROL OF AQUATIC WEEDS BY USE OF N2-CO2-HE LASER SYSTEMS ...**2.0091**

AQUATIC PLANT CONTROL BY HERBIVOROUS AMUR FISH ...**2.0092**

CHEMICAL CONTROL OF WEEDS IN PONDS ...**2.0093**

SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...**2.0095**

EFFECT OF ULTRASONIC ENERGY ON AQUATIC PLANTS ...**2.0096**

WEED CONTROL IN RICE PRODUCTION ...**2.0097**

WEED CONTROL IN RICE PRODUCTION ...**2.0098**

BIOLOGICAL CONTROL OF WEEDS ...**2.0099**

AQUATIC WEED CONTROL RESEARCH ...**2.0100**

BIOLOGICAL CONTROL OF WEEDS ...**2.0102**

EVALUATION OF MANAGEMENT PRACTICES ON THE STATE-OWNED WILDLIFE AREAS ...**2.0103**

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...**2.0104**

PHYSIOLOGY, BIOCHEMISTRY AND CONTROL OF AQUATIC WEEDS, CHEMISTRY OF HERBICIDES ...**2.0105**

AROMATIC SOLVENT AQUATIC HERBICIDES AND EMULSIFYING AGENT TESTING ...**2.0107**

HERBICIDE RESIDUES ...**2.0109**

GROWTH SUPPRESSION AND REDUCTION IN REGROWTH POTENTIAL OF AQUATIC WEEDS ...**2.0110**

LABORATORY STUDY OF AQUATIC ENVIRONMENTAL FACTORS AND PLANT GROWTH STAGES ON AQUATIC WEED GROWTH AND HERBICIDAL RESPONSE ...**2.0111**

AQUATIC PEST CONTROL ...**2.0112**

CONTROL OF AQUATIC WEEDS ...**2.0113**

CHEMICAL CONTROL OF DITCHBANK WEEDS IN PEAT AND SANDY SOIL AREAS OF SOUTH FLORIDA ...**2.0114**

BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0115**

EVALUATION OF HERBICIDES FOR CONTROL OF AQUATIC WEEDS ...**2.0116**

ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0117**

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0118**

PROCESSING, CHEMICAL COMPOSITION, AND NUTRITIVE VALUE OF AQUATIC WEEDS ...**2.0119**

SOUTHEASTERN BIOLOGICAL CONTROL OF WEEDS INVESTIGATIONS ...**2.0120**

WEED CONTROL IN CITRICULTURE ...**2.0123**

MASS REARING OF MARISA CORNUARIETIS FOR BIOLOGICAL CONTROL OF AQUATIC WEEDS IN EMPERATE WATERS ...**2.0124**

AQUATIC PLANT CONTROL ...**2.0128**

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0129**

THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...**2.0130**

GROWTH REGULATORS AND MINERAL NUTRITION IN AQUATIC PLANT CONTROL ...**2.0134**

NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...**2.0135**

THE USE OF FLAME FOR CONTROLLING WEEDS AND BRUSH ...**2.0136**

DETERMINATION OF THE EFFECTS OF A FERTILIZER-INDUCED PLANKTON TURBIDITY, SUPPLEMENTED BY HERBICIDES, ON SUBMERGED AQUATIC PLANTS ...**2.0137**

AQUATIC WEED CONTROL BY POND FISHES ...**2.0139**

FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS ...**2.0141**

FOREST AND FARM GAME HABITAT; FISH POND ...**2.0143**

INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...**2.0144**

INSECTS ASSOCIATED WITH AQUATIC WEED PESTS OF FOREIGN ORIGIN ...**2.0145**

EXPANDED AQUATIC PLANT CONTROL PROJECT ...**2.0146**

CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...**2.0154**

CONTROL OF UNDESIRABLE AQUATIC VEGETATION ...**2.0155**

CONTROL OF EURASIAN MILFOIL ...**2.0156**

CONTROL OF CANADA THISTLE AND WATER WEEDS ...**2.0158**

STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...**2.0159**

CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...2.0160
RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...2.0161
BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162
WATERLEVEL MANAGEMENT ON IMPOUNDMENTS OF LOW QUALITY SOILS ...2.0163
BIOLOGICAL CONTROL - TAMARISK AND OTHER PHREATOPHYTES ...2.0164
FACTORS CONTROLLING THE GROWTH OF THE AQUATIC WEED SALVINIA ...2.0166
INVESTIGATION OF AQUATIC WEED PROBLEMS AND MEANS OF CONTROL, WITH EMPHASIS ON BRAZILIAN WATERWEED ...2.0167
EUTROPHICATION - EFFECT OF WEED HARVESTING ...2.0169
NATURAL ENEMIES OF EURASIAN WATERMILFOIL IN PAKISTAN ...2.0173
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...2.0178
IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...2.0181
CHANGES IN WATER ENVIRONMENT RESULTING FROM AQUATIC PLANT CONTROL ...2.0183
CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...2.0185
METHODS FOR CONTROLLING ALLIGATORWEED AND OTHER WEEDS IN CANALS, WATERWAYS, AND ADJACENT WATERS IN THE SOUTHEASTERN U. S. ...2.0186
CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187
NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188
BIOLOGICAL CONTROL OF SNAILS AND SLUGS ...2.0269
INTERACTIONS BETWEEN AQUATIC PLANTS AND SEWAGE EFFLUENT ...4.0001
FIELD INVESTIGATION OF THE SUBMERSED AQUATIC ENVIRONMENT ...4.0003
TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005
LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010
BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...4.0012
ANATOMICAL, PHYSIOLOGICAL AND ECOLOGICAL STUDIES ON MYRIOPHYLLUM SPICATIU ...4.0013
THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0014
NUTRIENT CONTROL PROJECT - DETROIT LAKES, MINNESOTA ...4.0015
RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...4.0019
THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0020
EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...4.0023
ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024
NUTRIENT DYNAMICS IN AN ARTIFICIALLY ENRICHED LAKE ...4.0025
THE CHANGING DISTRIBUTION OF THE GENUS POTAMOGETON (PONDWEEDS) IN OHIO ...4.0026
EUTROPHICATION OF SHELTERED BAYS IN A LARGE LAKE ...4.0029
TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ...4.0030

Brush or Phreatophyte Control

CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...1.0004
WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...1.0005
RESPROUTING OF CHAPARRAL ...1.0017
PERSISTENCE AND MODES OF HERBICIDE DISSIPATION UNDER RANGELAND CONDITIONS ...1.0096
THE USE OF FLAME FOR CONTROLLING WEEDS AND BRUSH ...2.0136

Forbs (broadleaf Herbs)

CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...1.0025
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...1.0196
WEED CONTROL IN RICE PRODUCTION ...2.0097
WEED CONTROL IN RICE PRODUCTION ...2.0098
BIOLOGICAL CONTROL OF WEEDS ...2.0099
BIOLOGICAL CONTROL OF WEEDS ...2.0102
WEED CONTROL IN CITRICULTURE ...2.0123
THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...2.0130
FOREST AND FARM GAME HABITAT; FISH POND ...2.0143
CONTROL OF CANADA THISTLE AND WATER WEEDS ...2.0158
STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...2.0159
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE UPPER MISSOURI RIVER BASIN ...2.0160
RESPONSE OF PLANT COMMUNITIES TO SUSTAINED USE OF HERBICIDES ...2.0161
BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162
WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...2.0176
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...2.0178
WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...2.0179
CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...2.0187

Grasses or Sedges

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...1.0009
COMPARATIVE EFFECTS OF WEED COMPETITION, HERBICIDES AND OTHER WEED CONTROL PRACTICES ON PLANT RESPONSE ...1.0145
DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...1.0196
WEED CONTROL IN RICE PRODUCTION ...2.0097
WEED CONTROL IN RICE PRODUCTION ...2.0098
CHEMICAL CONTROL OF DITCHBANK WEEDS IN PEAT AND SANDY SOIL AREAS OF SOUTH FLORIDA ...2.0114
WEED CONTROL IN CITRICULTURE ...2.0123
NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...2.0135
THE USE OF FLAME FOR CONTROLLING WEEDS AND BRUSH ...2.0136
CONTROL OF CANADA THISTLE AND WATER WEEDS ...2.0158
BIOLOGY AND CONTROL OF AQUATIC WEEDS ...2.0162
WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...2.0176
CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...2.0178

Trees & Shrubs

FOREST AND FARM GAME HABITAT; FISH POND ...2.0143

Weed Contron in . . .

Cereal Crops

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...1.0010
FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...1.0089
HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...1.0107

DEVELOPMENT OF TILLAGE-REPLACING HERBICIDE SYSTEMS ...**1.0196**

ENVIRONMENTAL IMPLICATIONS OF PESTICIDE USAGE ...**1.0334**

WEED CONTROL IN RICE PRODUCTION ...**2.0097**

WEED CONTROL IN RICE PRODUCTION ...**2.0098**

THE USE OF FLAME FOR CONTROLLING WEEDS AND BRUSH ...**2.0136**

USE OF CHEMICALS ON RICE ...**2.0140**

FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS ...**2.0141**

WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...**2.0176**

Control in Other Areas

WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...**2.0176**

Fiber Crops

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...**1.0010**

BEHAVIOR OF SPECIFIC HERBICIDES IN PLANTS AND SOILS ...**1.0091**

CONTAMINATION OF SURFACE AND GROUND WATER WITH INSECTICIDES AND HERBICIDES APPLIED TO CULTIVATED CROPS ...**1.0189**

Forage Grasses, Pasture, Range

CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...**1.0004**

WATER YIELD IN THE CHAPARRAL AND WOODLAND ZONE OF THE SOUTHWEST ...**1.0005**

PERSISTENCE AND MODES OF HERBICIDE DISSIPATION UNDER RANGELAND CONDITIONS ...**1.0096**

WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...**2.0176**

Fruit Crops

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...**1.0010**

WEED CONTROL IN CITRICULTURE ...**2.0123**

Horticultural -nonspecific

WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...**2.0179**

Oilseed Crops

INACTIVATION AND LOSS OF PESTICIDES FROM SOIL ...**1.0002**

EFFICIENCY AND HAZARDS OF RESIDUAL HERBICIDES IN SOILS UNDER IRRIGATION. ...**1.0010**

CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...**1.0025**

HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...**1.0107**

Roadsides

WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...**2.0176**

Sugar Crops

HERBICIDE RESIDUES IN IRRIGATION WATER AND IN CROPS AND SOILS IRRIGATED WITH TREATED WATER ...**1.0107**

Vegetables

INVESTIGATIONS OF RESIDUES IN WATER AND CROPS IRRIGATED WITH WATER CONTAINING HERBICIDES ...**1.0015**

CONTROL OF WEEDS IN AGRONOMIC AND VEGETABLE CROPS WITH HERBICIDES ...**1.0025**

FATE AND PERSISTENCE OF PESTICIDES AND PHYSIOLOGICALLY ACTIVE DEGRADATION PRODUCTS ...**1.0089**

Wetlands

EVALUATION OF MANAGEMENT PRACTICES ON THE STATE-OWNED WILDLIFE AREAS ...**2.0103**

Weed Pathology

BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...**2.0121**

BIOLOGICAL CONTROL OF WATER WEEDS WITH PLANT PATHOGENS ...**2.0122**

A CRITICAL TEST OF METHODS FOR ISOLATION OF VIRUSES FOR USE IN CONTROL OF NUISANCE ALGAE ...**2.0133**

NATURAL ENEMIES OF WITCHWEED, NUTSEDGE, AND SEVERAL AQUATIC WEEDS IN INDIA ...**2.0135**

NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...**2.0188**

THE EFFECT OF POLLUTION ON THE DISTRIBUTION OF LPP PHYCO-VIRUSES IN RELATION TO POLLUTION OF THE CHRISTINA RIVER ...**4.0004**

BIOLOGIC AND ENVIRONMENTAL CONTROL OF EURASIAN MILFOIL (MYRIOPHYLLUM SPICATUM L.) IN CHESAPEAKE BAY ...**4.0012**

Weed Phenology

CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...**1.0004**

SEARCH FOR AND IMPORTATION OF INSECT ENEMIES OF AQUATIC WEEDS ...**2.0095**

BIOLOGICAL CONTROL OF WEEDS ...**2.0099**

AQUATIC WEED CONTROL RESEARCH ...**2.0100**

WEED CONTROL IN IRRIGATION AND DRAINAGE SYSTEMS ...**2.0104**

BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0115**

ECOLOGY AND BIOCONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0117**

THE PHYSIOLOGY AND CHEMICAL CONTROL OF AQUATIC WEEDS IN THE SOUTHEAST ...**2.0118**

TESTING OF NEW HERBICIDES ...**2.0125**

SURVEY OF POND WEEDS AND PLANT SUCCESSION ...**2.0127**

INSECTS ON FOREIGN AQUATIC WEEDS IN LOUISIANA ...**2.0144**

CONTROL OF CANADA THISTLE AND WATER WEEDS ...**2.0158**

STUDIES IN SOILS, CROPS, WATER MANAGEMENT AND WEED CONTROL UNDER IRRIGATED CONDITIONS ...**2.0159**

BIOLOGY AND CONTROL OF AQUATIC WEEDS ...**2.0162**

BIOLOGICAL CONTROL - TAMARISK AND OTHER PHREATOPHYTES ...**2.0164**

WEED CONTROL IN RICE FIELDS AND PASTURE LANDS IN THE GULF COAST AREA ...**2.0176**

CONTROL OF WEEDS IN AQUATIC AND NONCROP AREAS IN THE PACIFIC NORTHWEST ...**2.0178**

CONTROL OF AQUATIC AND NONCROPLAND WEEDS IN WYOMING, COLORADO, AND NEBRASKA ...**2.0187**

LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...**4.0010**

ANATOMICAL, PHYSIOLOGICAL AND ECOLOGICAL STUDIES ON MYRIOPHYLLUM SPICATIU ...**4.0013**

STUDIES IN PHYSIOLOGY ECOLOGY AND LIFE HISTORIES OF ALGAE ...**4.0022**

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...**4.0024**

Weed Physiology

CONTROL METHODS FOR JUNIPERS, SHRUB LIVE OAK, AND ASSOCIATED WEEDS ...**1.0004**

IMPROVING WATER QUALITY BY REMOVAL OF PESTICIDE POLLUTANTS WITH AQUATIC PLANTS ...**1.0216**

GROWTH SUPPRESSION AND REDUCTION IN REGROWTH POTENTIAL OF AQUATIC WEEDS ...2.0110

BASIC PHYSIOLOGY OF AQUATIC WEEDS IN THE SOUTHEAST ...2.0115

FACTORS INFLUENCING OCCURRENCE OF SELECTED AQUATIC PLANTS IN RICE FIELDS ...2.0141

CONTROL OF UNDESIRABLE AQUATIC VEGETATION IN LAKE TANEYCOMO, MISSOURI ...2.0154

THE ROLE OF TRACE ELEMENTS IN THE MANAGEMENT OF NUISANCE GROWTHS ...2.0174

WEED CONTROL IN IRRIGATED HORTICULTURAL CROPS IN WASHINGTON ...2.0179

CHEMICAL CONTROL OF AQUATIC WEED NUISANCES ...2.0185

FIELD INVESTIGATION OF THE SUBMERSED AQUATIC ENVIRONMENT ...4.0003

TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005

LIFE CYCLES OF ROTTBELLIA EXALTATA AND AMPHIBROMUS SCABRIVALVIS AND DEVELOPMENT OF CONTROL MEASURES ...4.0010

ANATOMICAL, PHYSIOLOGICAL AND ECOLOGICAL STUDIES ON MYRIOPHYLLUM SPICATIU ...4.0013

RELATIONSHIPS BETWEEN WATER QUALITY AND PLANT GROWTH IN PONDS ...4.0019

THE ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0020

EFFECTS OF EUTROPHICATION ON AQUATIC VEGETATION - PHASE II ...4.0023

ECOLOGY OF SELECTED SUBMERSED AQUATIC WEEDS ...4.0024

TISSUE ANALYSIS FOR NUTRIENT ASSAY OF NATURAL WATERS ...4.0030

Weeds -general

PROCESSING, CHEMICAL COMPOSITION, AND NUTRITIVE VALUE OF AQUATIC WEEDS ...2.0119

IMPROVING SURFACE WATER CONDITIONS THROUGH CONTROL AND DISPOSAL OF AQUATIC VEGETATION, PHASE II ...2.0181

AQUATIC PLANTS OF POLLUTED WATERS IN SOUTHWESTERN UNITED STATES ...4.0028

Wetlands

THE EFFECTS OF PESTICIDE RESIDUES ON LARVAL AND JUVENILE WINTER FLOUNDER IN THE WEWEANTIC RIVER ESTUARY, MASSACHUSETTS ...1.0253

MOSQUITO INVESTIGATIONS - RESEARCH AND DEVELOPMENT ...2.0060

Wildlife -nonspecific

INSECTS AFFECTING MAN AND ANIMALS: DISEASES TO MAN OR ANIMALS ...2.0010

DIAGNOSIS OF DISEASES IN WILDLIFE ...3.0134

Wildlife Breeding

DEVELOPMENT OF METHODS FOR COMMERCIAL PRODUCTION OF FROG LEGS FROM TADPOLES OF THE BULLFROG ...3.0028

RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT FINGERLINGS TO FURUNCULOSIS ...3.0041

RELATIVE RESISTANCE OF SELECTIVELY BRED BROOK AND BROWN TROUT YEARLINGS TO FURUNCULOSIS ...3.0042

FIELD TESTING OF SELECTIVELY BRED STRAINS OF BROOK AND BROWN TROUT UNDER PRODUCTION HATCHERY CONDITIONS ...3.0043

AQUICULTURE, SALMON CULTURE - RESEARCH ...3.0053

TESTING OF STOCKS OF OYSTERS FOR DISEASE RESISTANCE ...3.0077

ACQUIRED VS. GENETIC RESISTANCE IN OYSTERS ...3.0078

TESTS OF SELECTED SEED OYSTER STOCKS ON COMMERCIAL BEDS ...3.0079

DISEASE-RESISTANT OYSTERS ...3.0114

AQUICULTURE, OYSTER HATCHERIES - RESEARCH ...3.0118

Wildlife Habitats

DETERMINATION OF DIGESTION RATES FOR TROUT ...1.0346

EVALUATION OF MANAGEMENT PRACTICES ON THE STATE-OWNED WILDLIFE AREAS ...2.0103

THE USE OF NUTRIA, WATER BOWL AND GRASS CARP FOR THE CONTROL OF SUBMERGENT PLANTS ...2.0130

FISH PRODUCTION AND GAME MANAGEMENT ON THE IDLEWILD PLANTATION ...2.0142

FOREST AND FARM GAME HABITAT; FISH POND ...2.0143

WATERLEVEL MANAGEMENT ON IMPOUNDMENTS OF LOW QUALITY SOILS ...2.0163

Wind or Air Movement

INSECTS AFFECTING MAN AND DOMESTIC ANIMALS ...2.0087

RESEARCH VESSEL OPERATIONS ...3.0048

Winter

PATTERNS OF PESTICIDE CONTAMINATION OF WATER ...1.0039

EFFECTS OF WATER EXCHANGE AND BLUE CRAB CONTROL ON SHRIMP PRODUCTION IN LOUISIANA SALT-MARSH IMPOUNDMENTS ...2.0275

ECOLOGY OF MOSQUITOES OF ARID SOUTHEASTERN CALIFORNIA ...4.0039

WATER QUALITY REQUIREMENTS OF AQUATIC INSECTS ...4.0066

Wisconsin

GREEN BAY RESEARCH PROGRAM ...1.0112

CALIFORNIA ENCEPHALITIS VIRUS IN WISCONSIN ...4.0075

Wood

EVALUATION OF EFFECTS OF SATURATED HYDROCARBONS ON PRESERVATIVE QUALITY OF CREOSOTE ...2.0267

EFFECT OF PRETREATMENT MOLDING OF SOUTHERN PINE ON THE PERMANENCE OF THE PRESERVATIVE IN SEA-WATER EXPOSURE ...2.0295

MARINE PILING ANALYSIS ...2.0296

Wyoming

METHOXYCHLOR-CAUSED EFFECTS ON CUTTHROAT TROUT PHYSIOLOGY - CHRONIC TOXICITY OF INSECTICIDES TO COLD-WATER FISH ...1.0296

Xanthophyll

TOXIC SUBSTANCES AND CHEMICAL COMPOSITION OF HYACINTHS AND OTHER WATER PLANTS ...4.0005

Yugoslavia

NATURAL ENEMIES OF MYRIOPHYLLUM SPICATUM IN YUGOSLAVIA ...2.0188

Zeolites

ALTERING PERSISTENCE AND MOVEMENT OF HERBICIDES IN SOIL, WATER, AND PLANTS ...1.0106

Zoogeography

Nearctic - Zoogeography

BIONOMICS OF SELECTED NORTH AMERICAN CULICINE MOSQUITOES ...**4.0054**

Neotropical - Zoogeography

MOSQUITOES OF MIDDLE AMERICA ...**4.0037**

MOSQUITOES OF MIDDLE AMERICA ...**4.0038**

World Wide - Zoogeography

THERMAL STRESS AND POLYMORPHISM OF MOSQUITOES ...**4.0052**

INVESTIGATOR INDEX

Aaronson, S. -2.0165*
Abbott, U.K. -1.0322
Acree, F. -2.0028*
Adkins, T.R. -2.0081*
Ahlricks, J.L. -1.0041
Ahrens, J.F. -2.0113*
Akesson, N.B. -2.0009*
Alexander, G.R. -1.0346*
Allen, J.L. -1.0314*, 1.0315*, 2.0236*, 2.0237*, 2.0238*, 2.0239*
Allen, R.W. -2.0280*
Allison, R. -3.0001*, 3.0108*
Amend, D.F. -3.0084*, 3.0086, 3.0092, 3.0121*
Anderson, D.P. -3.0085*, 3.0122
Anderson, G.A. -2.0204*, 2.0205
Anderson, J.F. -2.0022*, 2.0023*
Anderson, R.O. -1.0366
Andres, L.A. -2.0099*
Andrews, J.D. -3.0077*, 3.0078*, 3.0079*
Andrews, P.S. -2.0201*
Applegate, H.G. -1.0365*
Applegate, R.L. -1.0203*
Argyle, R.L. -1.0113*, 1.0114*, 1.0229*, 1.0230*, 1.0231*
Armstrong, J.G. -1.0267*, 1.0268*, 1.0286, 1.0296
Asai, R.I. -1.0019
Ashley, L.M. -3.0080*, 3.0081*
Ashworth, B. -1.0209
Aslamkhan, M. -2.0048
Atkins, P.R. -1.0093*, 1.0210*
Aue, W.A. -1.0058*
Avault, J.W. -2.0139*
Avery, E.L. -2.0263*
Axtell, R.C. -1.0358*
Bachmann, R.W. -4.0008*
Bagnall, L.O. -2.0119*
Bailey, G. -1.0124*
Bailey, G.W. -1.0135
Bailey, M.M. -2.0235
Baker, D.E. -1.0090
Baker, J.B. -2.0140*, 2.0141*, 4.0010*
Baker, R.H. -2.0048
Baldridge, H.D. -2.0191*
Ball, G.H. -4.0036*
Ball, R.C. -1.0057, 1.0161*, 1.0339*, 1.0340*
Balthazar, E.E. -1.0226
Bang, Y.H. -4.0070
Banks, J.L. -3.0120*
Barlowe, R. -1.0162
Barnes, D.G. -1.0070*
Barnett, H.C. -2.0048*
Barr, A.R. -2.0012*, 2.0013*
Barr, H.T. -1.0049*
Barry, R.J. -2.0146
Bartels, P.G. -2.0096*
Bartley, T.R. -2.0106*, 2.0107*, 2.0108*, 2.0109*
Bartsch, A.F. -2.0168*, 2.0169*, 2.0170*, 2.0171*
Bass, J.C. -4.0078*
Bateman, B.A. -2.0142*, 2.0143*
Bay, E.C. -2.0014*
Beard, T. -4.0086*
Beaver, R.E. -2.0203
Becker, D.A. -3.0018*, 3.0019
Beckwith, D.G. -3.0061*
Beil, J. -2.0235
Beiningen, K. -3.0059
Belkin, J.N. -4.0037*, 4.0038*
Bellis, E.D. -2.0080*
Bender, M.E. -1.0257*, 1.0258*
Bendixen, L.E. -1.0191
Bennett, P.J. -1.0219
Berg, A.R. -1.0017
Berg, C.O. -2.0282*, 2.0283*
Berger, B.L. -2.0240*, 2.0241*
Berry, E.G. -2.0278*, 2.0279*
Bhagat, S.K. -1.0219
Bhalla, S.C. -2.0048
Bianchi, U. -2.0038
Bickley, W.E. -4.0063*
Biggar, J.W. -1.0012*, 1.0013*
Bingham, S.W. -1.0216*
Biniek, J. -1.0026*
Bishop, C.G. -3.0039*
Black, A.P. -1.0126*
Blackburn, R.D. -2.0116*, 2.0117*, 2.0124*, 2.0186
Blackman, R.R. -1.0242
Bland, C.E. -3.0115
Blanton, F.S. -2.0029
Bohart, R.M. -2.0010*
Bollag, J.M. -1.0087*
Bond, C.E. -2.0167*
Bond, H.W. -2.0290*
Booth, G.M. -1.0330
Borkovec, A.B. -2.0049*
Bouldin, D.R. -1.0186
Boush, G.M. -1.0222*
Boval, B.P. -1.0115
Bowen, V.T. -1.0158*
Bowman, C. -2.0159
Bowmer, K.H. -1.0010*
Boyd, K. -2.0083
Boyle, D.W. -2.0132*
Bradley, E.B. -1.0151*
Bradley, J.R. -1.0189
Brady, J.R. -2.0096
Braem, R.A. -2.0204, 2.0205*, 2.0209
Bratzler, L.J. -1.0259*
Braunheim, S.T. -1.0117
Breese, W.P. -1.0304
Brezner, J. -1.0067*
Brindley, W.A. -2.0086*
Brody, J.A. -4.0062
Brown, C.J. -4.0080*
Brown, D.A. -1.0008*, 1.0009
Bruce, W.N. -1.0037*, 1.0038*, 1.0330
Bruhn, H.D. -2.0181*, 2.0182*
Bruns, V.F. -2.0178*
Brunson, W.D. -1.0217*, 1.0310*, 1.0311*
Bryan, E.H. -1.0187*
Buchanan, G.A. -1.0001
Bugher, R.D. -1.0142
Buhler, D.R. -1.0303*
Bukovac, M.J. -1.0057
Bulkley, R.V. -1.0247*
Bullock, G.L. -3.0096*, 3.0097*, 3.0098*, 3.0127
Bunting, D.L. -1.0207*
Burbank, N.C. -1.0036
Burge, R.T. -3.0022
Burnett, E. -1.0101
Burns, E.C. -2.0040*
Burress, R.M. -1.0108*, 2.0240, 2.0242*
Burrows, C. -2.0212*
Burt, G.W. -1.0154
Burt, W.V. -3.0048*
Butcher, J.W. -1.0057, 1.0341*
Butler, P.A. -1.0238*
Buyers, A.G. -4.0021
Cairns, J. -1.0308*
Calabrese, A. -1.0236
Campbell, H.J. -3.0119
Campbell, R.S. -1.0366
Campbell, W.R. -2.0035
Capel, S. -1.0150
Cardarelli, N.F. -2.0284*, 2.0285*, 2.0286*
Carlile, B.L. -1.0104*, 1.0218*
Carlson, C.W. -1.0109*
Carman, G.E. -2.0268*
Carr, J.F. -1.0160, 1.0256
Carter, L.R. -1.0147*
Catts, E.P. -1.0327*, 2.0024*
Chandler, L. -1.0039*
Chang, P.W. -3.0069*
Chao, J. -4.0036
Chapman, H.C. -2.0043*
Cheng, E. -1.0168
Cheng, H.H. -1.0105*
Chernin, E. -2.0277*
Chester, G. -1.0109
Chesters, G. -1.0110*, 1.0223*, 1.0224*, 2.0185
Chew, R.M. -4.0039*
Childers, W.F. -1.0038, 1.0330
Christenson, L. -3.0106
Clausz, C. -1.0070
Cohen, S.D. -1.0255
Cole, C.F. -1.0253*, 1.0254*
Colley, F.C. -2.0270
Collins, D.L. -4.0042*
Colwell, R.R. -3.0026*
Combs, B.D. -2.0177*
Comes, R.D. -2.0178
Conrad, J. -3.0059
Contini, C. -2.0038
Cook, A.A. -2.0121, 2.0122
Cook, D.W. -3.0037*
Cook, E.F. -2.0054*
Cooper, G.R. -1.0336
Coppage, D.L. -1.0239*
Corcoran, E.F. -1.0130*
Corden, M.E. -1.0082*
Correll, D.S. -4.0028*
Cottam, G. -2.0183*
Couch, J.N. -2.0072*
Couch, R. -2.0091*
Coulson, D.M. -1.0015
Courtney, W.R. -1.0237*
Cousineau, J.G. -3.0023*
Crabtree, J.E. -3.0072*
Craig, G.B. -4.0055*
Crosby, D.G. -1.0322
Cross, C.E. -1.0056
Cross, J.H. -4.0068*
Croston, C.B. -1.0309*
Crowell, H.H. -2.0288*, 2.0289*
Culley, D.D. -1.0249*, 3.0028*
Cutkomp, L.K. -1.0168*, 1.0265*, 1.0266*, 2.0055*
Dadd, R.H. -4.0033*, 4.0034*
Dahm, P.A. -1.0043*
Daniel, C. -1.0231
Darrow, R.A. -2.0205
Davie, J. -1.0233
Davis, D.E. -4.0001*
Davis, F.S. -1.0096
Davis, H.C. -1.0236*
Davis, P. -1.0312
Dawson, J.H. -1.0106*
Dawson, V.K. -1.0316, 2.0243*, 2.0244*, 2.0255, 2.0256, 2.0257, 2.0258, 2.0259
Demint, R.J. -2.0105

*INDICATES PRINCIPAL INVESTIGATOR

INVESTIGATOR INDEX

Derrington, C.F. -1.0171*
Detels, R. -4.0062*
Deubert, K.H. -1.0055*, 1.0056*
Devlin, R.M. -4.0014*
Dicke, R.J. -2.0087*
Dimond, A.E. -2.0113
Dimond, J.B. -1.0335*
Dindal, D.L. -1.0078
Dixon, J.R. -2.0082
Dobie, J. -2.0153*
Dobrotworsky, N.V. -4.0050
Donaldson, J.R. -2.0228*, 4.0083
Doneen, L.D. -1.0012
Dornbush, J.N. -1.0204*
Doudoroff, P. -1.0304
Douthit, C.F. -1.0132
Doxtader, K.G. -1.0023*
Dregne, H.E. -1.0065*
Dugan, P.R. -4.0027
Dumas, R.F. -3.0041*, 3.0042*, 3.0043*, 3.0044*
Dunstan, G.H. -1.0219
Dupree, H.K. -1.0113, 1.0114, 1.0229, 1.0230, 1.0231
Durant, C.J. -1.0139
Dutt, G.R. -1.0006*
Earnest, R.D. -1.0234*
Easley, J.F. -4.0005
Eastin, E.F. -1.0095*
Ebel, W.J. -3.0083*
Eden, W.G. -4.0048*
Edwards, H.W. -1.0123*
Edwards, V.H. -1.0185*
Ehrlich, S. -2.0130*
Eirich, D. -3.0126
Eldridge, B.F. -4.0046*
Ellarson, R.S. -1.0367*
Elliott, J.W. -3.0120
Ensign, J.C. -2.0184*
Epstein, E. -1.0051*
Erb, D. -2.0159
Ercegovich, C.D. -1.0088*, 1.0089
Escutia, V. -2.0083
Estes, R.D. -2.0128
Evans, J.O. -1.0103
Fahey, J. -1.0040*
Fairchild, M.L. -1.0059*
Fang, S.C. -1.0360
Farley, C.A. -3.0033*, 3.0034, 3.0113*
Farmer, W.J. -1.0016*
Feltner, K.C. -1.0334
Feng, T.H. -1.0155*
Ferguson, H. -2.0159
Ferrigno, F. -2.0063*, 2.0064*, 2.0065*, 2.0066*
Fetterolf, C.M. -1.0163*, 1.0164*
Field, G. -4.0069*
Fikes, M. -1.0301
Fisher, H.W. -1.0200*
Fisher, T.W. -2.0269*
Flashinski, S.J. -1.0111
Flinchum, W.T. -2.0176*
Foote, B.A. -2.0287*
Forbes, R.B. -1.0029*
Foret, J.A. -2.0146*
Fowler, L.G. -3.0120
Frank, P.A. -2.0105*
Frea, J.I. -4.0027
Frear, D.E. -1.0089*, 1.0306
Freed, V.H. -1.0360*, 1.0361*
Freedland, R.A. -1.0322
Freeman, T.E. -2.0121, 2.0122
Fremling, C.R. -1.0169*
French, J.M. -1.0320
French, W.L. -2.0041*
Frizzi, G. -2.0038*
Fromm, P.O. -1.0260*
Fryer, J.L. -3.0049*, 3.0050*, 3.0051*, 3.0057*, 3.0116*, 3.0117*
Fuhremann, T.W. -1.0111
Fukuto, T.R. -2.0015*, 2.0017
Fuller, G.C. -2.0290
Funderburk, H.H. -1.0228*, 1.0319*
Gahan, J.B. -4.0047*
Garber, D.P. -1.0320
Gardner, W.H. -1.0104
Garrison, R.L. -3.0119
Gaston, L.K. -2.0017
Gaudet, J.J. -2.0166*
Gaufin, A.R. -1.0297*, 4.0066*
Gaylord, W.E. - 2.0203*, 2.0204, 2.0209
Gaynor, J.D. -1.0085
George, H. -2.0103*
Georghiou, G.P. -2.0015, 2.0016*, 2.0017*
Gerloff, G.C. -4.0030*
Getzin, L.W. -2.0294*
Ghani, M.A. -2.0173*
Gibbs, C.J. -4.0062
Giddens, J.E. -1.0030*
Gilbert, B. -2.0266*
Gilderhus, P.A. -2.0240, 2.0245*, 2.0246*, 2.0247*
Gjovik, L.R. -2.0295*
Gloyna, E.F. -1.0210
Goerlitz, D.F. -1.0119*
Golden, R.D. -2.0102*
Goleman, D.L. -1.0193
Goodin, J.R. -1.0017*
Goodson, L. -1.0180*
Goolsby, D.A. -1.0134*
Gossett, B.J. -1.0091*
Gould, G.I. -1.0320
Goulding, R.L. -2.0077*, 2.0078*
Grant, B.F. -1.0267, 1.0269*, 1.0270*, 1.0271*, 1.0272*, 1.0288, 1.0289, 1.0290, 1.0291, 1.0318
Grant, F.B. -1.0273*
Green, R.E. -1.0034*, 1.0035*
Greichus, Y.A. -1.0092, 1.0205, 1.0364*
Griffith, W. -1.0235*
Grissinger, E.H. -1.0170
Grothaus, R.H. -2.0074*
Guenzi, W.D. -1.0024
Guilbault, G.G. -1.0153*
Guira, J.E. -4.0049
Gunstream, S.E. -4.0039
Gunther, F.A. -1.0018*, 1.0019*, 1.0324
Guptavanij, P. -4.0072
Guttman, H.N. -2.0133*
Guyer, G.E. -1.0057*
Haan, C.T. -1.0047*
Haeusermann, W. -4.0055
Hafez, M. -2.0085*
Hagmann, L.E. -2.0060*
Hagstrum, D. -4.0039
Hajek, B.F. -1.0001
Hall, J.K. -1.0090*
Hall, M.W. -4.0011*
Halver, J.E. -1.0309, 3.0080, 3.0081
Hamelink, J.L. -1.0148*, 1.0246*
Hammer, D.A. -2.0292*
Hammond, L.C. -1.0027, 1.0028
Hansen, D.J. -1.0240*
Hanson, L.H. -2.0210*, 2.0211
Harinasuta, C. -4.0072*
Harris, A.H. -2.0275
Harris, D.O. -2.0138*
Harrison, R.M. -1.0031*
Harrold, L.L. -1.0194*
Hartberg, W.K. -4.0070
Hartel, D.N. -1.0132
Hartman, G.F. -3.0106*
Hartmann, R. -1.0150*
Harvey, G.R. -1.0159*
Harwood, R.F. -4.0074*
Haskin, H.H. -3.0114*
Hassinger, R. -2.0213*
Hastings, C.E. -4.0076*
Hastings, E. -2.0058*, 2.0059*
Hathaway, E.S. -2.0042*, 2.0044*, 2.0045*
Hauser, V.L. -1.0079
Havey, K.A. -2.0200*
Hawrylewicz, E.J. -4.0051
Hayes, J. -2.0083
Haynes, D.L. -2.0053*
Haynes, R.R. -4.0026*
Haynes, W.S. -2.0267
Hays, K.L. -2.0001*
Hehn, E.R. -2.0159
Helfrich, P. -3.0110*
Helm, W.T. -4.0029*
Helmboldt, C.F. -3.0024*
Henson, J.W. -1.0208*
Hentges, J.F. -2.0119, 4.0005
Herman, R.L. -3.0099*, 3.0127*
Hermanson, H.P. -1.0018
Herrig, R.G. -3.0058*
Hesse, J. -1.0163
Hibbert, A.R. -1.0005*
Hickey, J.J. -1.0368*
Hickey, W.A. -4.0055
Hiler, E.A. -1.0211*
Hill, D.W. -1.0135*
Hilsenhoff, W.L. -1.0225*, 2.0088*
Hiltbold, A.E. -1.0001*, 1.0002*
Hiltibran, R.C. -1.0329*, 1.0330
Hiltz, R. -1.0086*
Himel, C.M. -1.0137*
Hinden, E. -1.0219*
Hinton, D.E. -1.0248*.
Hochman, H. -1.0121*
Hodges, J.W. -2.0203
Hodgson, J.M. -2.0158*, 2.0159*, 2.0160*, 2.0161*
Hoffman, C.E. -3.0019
Hoffman, G.L. -3.0100*, 3.0101*, 3.0102*, 3.0105, 3.0128*, 3.0129*, 3.0130*, 3.0131, 3.0132
Hogan, J.W. -1.0274*, 1.0275*, 1.0276*, 1.0348*
Holt, R.A. -3.0116
Hoopingarner, R.A. -1.0057
Hopkins, T.L. -1.0046*, 1.0334*
Hopkins, T.S. -1.0133*
Horsfall, W.R. -4.0052*
Hortenstine, C.C. -1.0027*
Horton, H.F. -3.0052*
Howard, R.G. -2.0100*, 2.0104
Howell, G.S. -2.0150*
Howell, J.H. -2.0211*
Howlett, H.A. -1.0184
Hu, S.M. -2.0047, 4.0061
Huang, J.C. -1.0181*
Huber, C.O. -1.0227*
Huber, R.T. -4.0053*
Hubert, A.A. -4.0058*
Huffaker, C.B. -2.0006*
Hughes, J.S. -1.0251*, 3.0111*, 3.0112*
Huish, M.T. -1.0138*
Hunn, J.B. -2.0248*, 2.0249*, 2.0250*, 2.0251*, 2.0252*, 2.0253*, 2.0254*
Hutchinson, D.C. -1.0277, 1.0278
Irizarry, R. -2.0195*
Isaac, R.A. -1.0156*
Ito, T. -1.0188*
Jackson, R.K. -1.0013
Jenkins, J.H. -1.0138
Jester, D.B. -4.0081*
Jobbins, D.M. -2.0061*, 2.0062*
Johnsen, T.N. -1.0004*
Johnson, B.T. -1.0349*, 1.0350*, 1.0351*, 1.0352*
Johnson, C.L. -3.0080, 3.0081
Johnson, F.H. -2.0214*, 2.0215*
Johnson, H.E. -1.0161, 1.0261*, 1.0343
Johnson, H.P. -1.0044*
Johnson, K. -3.0059
Johnson, M.W. -3.0035*
Johnston, L. -4.0043*
Johnston, P.M. -3.0019*
Johnstone, D.B. -1.0213*
Jolliff, T.M. -2.0221*, 2.0222*, 4.0082*
Jones, D.W. -2.0032
Jones, E.R. -1.0052*
Jones, R.H. -4.0045*
Judge, F.D. -2.0281*
Kallio, R.E. -1.0331*
Kanakkanatt, S.V. -2.0284, 2.0285
Kaplovsky, A.J. -1.0182*
Kashin, P. -4.0051*
Katkansky, S.C. -3.0022
Katz, M. -1.0313*
Kausch, R.C. -1.0184
Kearney, P.C. -1.0071*
Keating, J.F. -2.0196*, 4.0077*
Keeney, D.R. -2.0185*
Keller, M. -2.0202*
Keltner, J.M. -1.0128
Kendle, E.R. -2.0217*
Kennedy, H.D. -1.0275, 1.0277*, 1.0278*, 1.0279*, 1.0280*
Kerr, J.P. -1.0245*
Keth, J.O. -1.0325*
Kevern, N.R. -1.0161, 1.0162, 1.0339, 1.0340, 1.0342*
Kidd, D. -4.0021
Kilambi, R.V. -3.0019

*INDICATES PRINCIPAL INVESTIGATOR

INVESTIGATOR INDEX

Kilgore, W.W. -1.0322*
King, E.L. -2.0210, 2.0211
King, L.G. -1.0102*
Kingsbury, J.M. -4.0022*
Kircheis, F. -3.0030*
Kitzmiller, J.B. -2.0034*
Klaassen, H.E. -1.0334
Klontz, G.W. -3.0074*
Knake, E.L. -1.0145*
Knapp, D.B. -1.0325
Knapp, F.W. -2.0039*
Knapp, S.E. -3.0054
Knight, K.L. -2.0075*
Knisel, W.G. -1.0101*
Knispel, W. -2.0229*
Knudson, V.A. -1.0343*
Koch, W.J. -2.0072
Kokernot, R.H. -2.0083*
Kolodziej, B.J. -4.0027
Koplin, J.R. -1.0320*
Korn, S. -1.0284
Krausz, N.G. -1.0332*
Krueger, R. -1.0163
Kuenzler, E.J. -2.0073*
Kuitert, L.C. -2.0029*
Kunze, G.W. -1.0211
Kuo, E.C. -1.0085
Kurtz, A. -1.0306*
Lake, R.W. -2.0025*
Lancaster, J.L. -2.0003*, 2.0004*, 4.0032*
Lane, C.E. -1.0243*, 1.0244*
Laneman, G. -1.0209
Larson, W.C. -4.0015*
Lathwell, D.J. -1.0186
Lau, L.S. -1.0036*
Laudani, U. -2.0038
Lavy, T.L. -1.0061*
Lawless, E.W. -1.0060*
Lawrence, J.M. -1.0228, 1.0319, 2.0092*, 2.0093*, 2.0094*
Lebrecque, G.C. -2.0026*
Lecis, A. -2.0038
Lee, G.B. -1.0223, 1.0224, 1.0226*
Leeling, N.C. -1.0259, 1.0261, 1.0262*, 1.0344*
Leith, D. -3.0059
Lekic, M. -2.0188*
Leland, B.J. -1.0143*, 1.0328*
Leland, H.V. -1.0146*
Lennon, R.E. -1.0366*
Leonard, D.E. -1.0335
Lesser, C.A. -2.0272*
Letey, J. -1.0016
Lewallen, M.J. -1.0032*
Lewis, G.C. -1.0141*
Lichtenstein, E.P. -1.0111*
Lie, K.J. -2.0270*
Lien, R.M. -2.0136*
Lindquist, D.A. -2.0030*
Lindsay, C. -3.0082*
Linn, J. -2.0189*
Livermore, D.F. -2.0181, 2.0182
Lloyd, J.E. -2.0090*
Lockwood, J. -1.0057
Loeb, H.A. -2.0223*, 2.0224*, 2.0225*
Lom, J. -3.0101
Lowe, J.I. -1.0241*
Luckmann, W.H. -1.0038, 1.0330*
Lueschow, L.A. -1.0221*
Lutz, J.F. -1.0071, 1.0072*, 1.0073*, 1.0074
Macek, K.J. -1.0281*, 1.0282*, 1.0283*, 1.0284*, 1.0337*
Machadoallison, C. -4.0055
Mackenzie, C.L. -2.0271*
Maclinn, W.A. -1.0064*
Maddox, D.M. -2.0186
Mahoney, J.B. -3.0040*
Maibach, H.I. -4.0041*
Maloney, J.E. -3.0036*
Maloney, T.E. -1.0125*
Malueg, K.W. -2.0168, 2.0169, 2.0171
Mameli, M. -2.0038
Manion, P.J. -2.0206*
Manning, J.H. -4.0012*
Mansell, R.S. -1.0027, 1.0028*
Manzi, J.J. -2.0271
March, R.B. -2.0015
Marking, L.L. -1.0316*, 2.0255*, 2.0256*, 2.0257*, 2.0258*, 2.0259*
Marshall, H.L. -2.0073
Marshall, L.C. -4.0007*
Martin, J.P. -1.0011*, 1.0020*
Martin, W.W. -2.0071, 2.0072
Mathieson, A.C. -4.0018*
Matsumura, F. -1.0222, 2.0089*
Mauck, W.L. -1.0353
May, D.S. -1.0219
Mayer, F.L. -1.0268, 1.0285*, 1.0286*, 1.0287*, 1.0353*
McClelland, G.A. -2.0010, 4.0070
McCoy, R.H. -3.0116
McCracken, R.J. -1.0074*
McCrory, H.F. -4.0064*
McDaniel, I.V. -2.0046*
McDonald, D.B. -1.0149*
McDowell, L.L. -1.0170*
McElwain, I. -3.0103
McFarland, L.Z. -1.0322
McGinty, D.J. -2.0199*
McHenry, J.R. -1.0170
McIlhenny, W.F. -2.0151*
McKee, S. -2.0284
McKee, T. -3.0059
McKenna, E.J. -1.0331
McKinney, J.M. -3.0062*, 3.0063*, 3.0064*, 3.0065*, 3.0066*, 3.0067*, 3.0068*
McLean, E.O. -1.0191
McMillion, L.G. -1.0079
McNabb, C.D. -1.0161
McNeal, B.L. -1.0104
McNeil, W.J. -3.0053*, 3.0118*
McNeish, J.D. -1.0252*
Mechalas, B.J. -1.0116*, 1.0117
Medem, F. -4.0044*
Megard, R.O. -4.0016*
Mehrle, P.M. -1.0269, 1.0287, 1.0288*, 1.0289*, 1.0290*
Meisch, M.V. -2.0003
Menn, C.T. -2.0231*
Menzel, D.W. -1.0140*
Menzel, R.G. -1.0080*
Menzer, R.E. -1.0154
Merkle, M.G. -1.0095
Merna, J.W. -1.0263*, 1.0264*
Merrell, T.R. -1.0232*
Metcalf, R.L. -1.0333*
Meyer, F.P. -3.0020*
Michael, T. -2.0047
Michelson, E.H. -2.0277
Mick, D. -1.0149
Micklus, R. -2.0216*
Middleton, J.E. -1.0104
Millemann, R.A. -1.0304*
Millemann, R.E. -1.0305*, 3.0054*
Miller, B.S. -3.0021
Miller, C.W. -1.0127*
Miller, G.C. -3.0047*
Miller, G.T. -1.0070
Miller, H.N. -2.0121
Miller, L.T. -3.0069
Miller, R.G. -2.0203
Milliff, R.H. -3.0076
Mills, D. -3.0059
Ming, A.D. -1.0356*
Mintz, D.S. -1.0291*
Mitchum, D.L. -3.0107*, 3.0133*
Monke, E.J. -1.0041*
Montgomery, A.B. -2.0128*
Moon, D.H. -1.0292
More, H.H. -2.0207
More, W.R. -3.0073*
Morman, R.H. -2.0203, 2.0204, 2.0209
Mortland, M.M. -1.0057
Motto, H.L. -4.0019
Mueller, C.C. -1.0104
Mulla, M.S. -1.0324*, 2.0018*
Mulligan, H.F. -1.0186, 4.0023*, 4.0024*
Mullin, S.W. -2.0270
Mullins, J.T. -2.0031*
Murphey, F. -2.0025
Murphy, S.D. -1.0255*
Murray, D.L. -2.0133
Murray, G. -2.0233
Musick, J.A. -2.0233*
Narang, S.L. -2.0013
Naylor, D.V. -1.0141
Neel, J.K. -4.0025*
Neff, S.E. -4.0073*
Negi, N.S. -1.0228
Nelms, G.E. -2.0090
Nelson, J.L. -1.0106, 1.0107
Nelson, W.E. -1.0003*
Newsom, L.D. -1.0250*
Nicholson, B.P. -3.0031*
Nickum, J.G. -1.0205*
Nielsen, D.R. -1.0013
Nimmo, D.W. -1.0242*
Oborn, E.T. -1.0292*
Oconnor, J.E. -1.0068
Odlaug, T.O. -1.0167
Ogg, A.G. -2.0179*
Oleary, G.P. -3.0071*
Oliver, A.D. -2.0144*, 2.0145*
Olney, C.E. -1.0201*, 1.0202*
Olson, D.E. -4.0079*
Olson, T.A. -1.0166*, 1.0167*, 4.0017*
Ominde, S. -4.0059*
Orcutt, H.G. -3.0022
Ordal, E.J. -3.0126*
Orear, C.W. -3.0046*
Orsenigo, J.R. -2.0114*
Osmun, J.V. -4.0054*
Otto, N.E. -2.0106, 2.0107, 2.0110*, 2.0111*, 2.0112*, 4.0003*
Owens, A.G. -2.0042
Palmer, J.S. -1.0212*
Pan, S.C. -2.0277
Pant, C.P. -4.0070
Paschke, J.D. -2.0035*
Patrick, R. -2.0174*
Patterson, C.E. -4.0021
Payne, B.R. -1.0062*
Payne, W.R. -1.0135
Pearce, G. -2.0051*
Pearce, W.A. -2.0220*
Pearson, W.G. -4.0071
Peneke, E.S. -1.0345*
Peoples, S.A. -1.0322
Perkins, B.D. -2.0095*
Peterle, T.J. -1.0078*
Peters, A. -1.0199*
Peters, T.M. -2.0052*
Peterson, D.H. -1.0120*
Peterson, R.P. -4.0015
Pfister, R.M. -4.0027*
Phaup, J.D. -4.0009*
Phillips, R.E. -1.0048*
Phillips, R.L. -2.0123*
Pilcher, K.S. -3.0049, 3.0051, 3.0116
Pippin, W.F. -2.0084*
Plum, W.B. -1.0121
Plumb, J.A. -3.0002*, 3.0003*, 3.0004*, 3.0005*, 3.0006*, 3.0007*, 3.0008*, 3.0009*, 3.0010*
Poertner, H. -1.0142
Poff, R. -2.0264*
Pollard, H. -2.0197*
Pollard, J.F. -2.0274*
Porges, R. -1.0184
Powell, J. -1.0233
Prashad, V. -4.0055
Pratt, I. -3.0055*
Presley, H.J. -2.0134*
Price, K. -2.0128
Pringle, B.H. -2.0291*
Pulford, E. -3.0059*
Pund, W.A. -4.0064
Purvis, H.A. -2.0207*
Putz, R.E. -3.0100, 3.0102, 3.0103*, 3.0105*, 3.0128, 3.0129, 3.0130, 3.0131*, 3.0132*
Pycha, R.L. -2.0235*
Querry, M.R. -1.0177*
Quinn, S. -2.0284
Quraishi, M.S. -1.0077*
Ragotzkie, R.A. -1.0112*, 1.0317*
Rahn, E.M. -1.0025*
Rai, K.S. -2.0036*
Raleigh, S.M. -1.0090
Ramalingam, S. -4.0055, 4.0060*
Randles, C.I. -4.0027
Rao, V.P. -2.0135*
Rappleye, R.D. -4.0013*
Raun, E.S. -2.0037*
Rayner, H.J. -3.0119*
Rayner, J.H. -2.0228, 4.0083*
Reeves, E.L. -2.0007*, 2.0019*
Reeves, R.L. -2.0020*

*INDICATES PRINCIPAL INVESTIGATOR

INVESTIGATOR INDEX

Reilly, J.R. -1.0359*
Reimold, R.J. -1.0139*
Reinbold, K.A. -1.0330
Reinert, R. -1.0160*, 1.0256*, 1.0338*
Reuszer, H.W. -1.0041
Reynolds, T.D. -1.0211
Rich, E.D. -2.0124
Richards, C.S. -2.0276*
Richardson, C.W. -1.0101
Riemer, D.N. -2.0162*, 4.0019*, 4.0020*
Ries, S.K. -1.0057, 2.0150
Riewe, M.E. -2.0082*
Ritter, W.F. -1.0044
Roan, C.C. -4.0031*
Roberts, D.W. -2.0070*, 2.0071*
Roberts, R.H. -2.0056*, 4.0064, 4.0065*
Roberts, S. -1.0104
Robinson, R.M. -3.0075*
Rodgers, C.A. -1.0293*, 1.0348
Rodriguez, D.P. -4.0055
Roedel, P.M. -3.0022*
Rogers, W.A. -3.0011*, 3.0012*, 3.0013*, 3.0014*, 3.0015*, 3.0109*
Rogoff, W.M. -2.0011*
Romey, D. -3.0059
Rose, C.D. -2.0275*
Rosen, L. -2.0047
Rosenfeld, A. -1.0173
Rosenfield, A. -3.0033, 3.0034*
Ross, A.J. -3.0085, 3.0086*, 3.0087*, 3.0090, 3.0091, 3.0093, 3.0121, 3.0122*, 3.0123*
Roth, H.G. -2.0295
Rowley, W.A. -4.0056*, 4.0057*
Rozeboom, L.E. -2.0047*, 4.0061*
Rucker, R.R. -3.0088*
Rugen, P.C. -2.0205, 2.0208*
Rutledge, W.P. -4.0084*, 4.0085*
Ryan, E.P. -3.0115*
Sakai, R.K. -2.0048
Salomon, M. -1.0202
Samson, K.S. -2.0280
Sanders, D.P. -2.0082
Sanders, H.O. -1.0275, 1.0294*, 1.0354*, 1.0355*
Santelmann, P.W. -1.0081*
Sayre, R. -2.0230*
Scalf, M.R. -1.0079*
Scanlon, J.E. -2.0083
Schaefer, C. -2.0008*, 4.0035*
Scheffer, T.C. -2.0296*
Schick, R. -4.0038
Schinazi, L.A. -1.0117*
Schmidt, M.L. -4.0067*
Schneider, A.D. -1.0094*
Schoettger, R.A. -1.0366, 2.0260*, 2.0261*, 2.0262
Schoonover, R.E. -2.0137*
Schults, D.W. -2.0168, 2.0169, 2.0171
Schultz, L.P. -2.0273*
Schulz, J.T. -2.0076*
Schulz, K.R. -1.0111
Schwab, G.O. -1.0191*, 1.0192*
Schwiesow, W.F. -1.0154*
Scifres, C.J. -1.0096*
Sclymosy, S.L. -2.0146
Seabra, A.P. -2.0266
Sears, H.S. -1.0232
Seiber, J.N. -1.0322
Seyb, L.P. -2.0172*
Shane, M.S. -4.0004*
Shannon, E.H. -2.0226*
Shannon, L.R. -1.0247
Sheets, T.J. -1.0075*, 1.0189*
Shellenberger, T.E. -1.0152*
Shirley, R.L. -2.0119, 4.0005*
Sieling, F.W. -3.0032*
Sigel, M.M. -3.0027*
Sigler, W.F. -4.0029
Sills, J.B. -1.0314, 1.0315, 2.0236, 2.0237, 2.0238, 2.0239
Silverstein, F.A. -4.0023
Simco, J.S. -2.0005*
Sinnhuber, R.O. -3.0056*
Sis, R.F. -3.0076*
Skinner, W.A. -4.0040*
Skye, G.E. -4.0049
Slack, K.V. -4.0002*
Slife, F.W. -1.0145
Smith, A.G. -1.0325
Smith, B.R. -2.0209*
Smith, D.E. -4.0006*
Smith, G.E. -1.0178*, 1.0179*
Smith, J.M. -1.0115*
Smith, R.C. -1.0132
Smith, R.J. -2.0097*, 2.0098*
Smith, R.L. -1.0103*
Smith, R.M. -1.0253, 1.0254
Smith, R.R. -3.0080
Smith, W.W. -2.0032*
Snow, C.D. -3.0060*
Solberg, R.A. -1.0297
Sollersriedel, H. -4.0042
Spacie, A. -1.0357*
Spencer, N. -2.0120*
Spencer, W.F. -1.0021*
Spillett, J.J. -2.0292
Sprugel, G. -1.0144*
Staba, E.J. -2.0152*
Stalling, D.L. -1.0173*, 1.0174*, 1.0267, 1.0293, 1.0295*, 1.0354
Stanley, J.G. -3.0106
Stark, R.W. -1.0321*
Steelman, C.D. -2.0040
Steffan, W.A. -4.0050*
Steinhauer, W. -1.0159
Stengle, T.J. -1.0214*
Stephenson, M.E. -1.0162*
Stevenson, F. -2.0227*
Steward, K.K. -2.0115*
Stewart, G.F. -1.0012
Stewart, N.E. -1.0304
Stiff, M.L. -2.0146
Stitt, L.L. -1.0063*
Strong, F.M. -2.0265*
Stuckey, H.M. -3.0096, 3.0097, 3.0098
Stucky, N. -1.0298*
Styron, C. -1.0070
Suffet, I.H. -1.0198*
Sullivan, R.H. -1.0142*
Summerfelt, R.C. -3.0038*
Suskind, R.R. -1.0190*
Svendsen, G.E. -2.0260, 2.0262*
Swedberg, D. -1.0296*
Swedburg, D.V. -1.0318*
Sweeny, K.H. -1.0014*, 1.0118*, 1.0323*
Swoboda, A.R. -1.0097*
Tadano, T. -2.0013
Talbert, R.E. -1.0009*
Talekar, N.S. -1.0111
Tallent, W.H. -2.0198*
Tarrant, R.F. -1.0083*
Tash, J.C. -2.0170
Taylor, A.W. -1.0053*, 1.0054*
Taylor, B.F. -1.0131*
Teas, H.J. -1.0132*
Terriere, L.C. -1.0304
Terwedow, H. -4.0055
Tesfayohannes, T. -4.0061
Thomas, A.E. -3.0120
Thomas, G.W. -1.0098*
Thomaston, W.W. -2.0125*, 2.0126*, 2.0127*, 2.0194*
Thompson, E.G. -4.0071
Thompson, E.M. -1.0300
Thompson, L.F. -2.0175*
Thompson, N.R. -2.0045
Thompson, W.H. -4.0075*
Thomson, J.M. -1.0233*
Thorne, E.T. -3.0134*
Thorsteinson, A.J. -2.0021*
Tilstra, J.R. -2.0168, 2.0169, 2.0171
Timmons, F.L. -1.0015*, 1.0107*, 2.0186*, 2.0187*
Tindle, R.C. -1.0173, 1.0175*, 1.0176*, 1.0295
Tinsley, I.J. -1.0360
Tipton, V.J. -4.0071*
Tompkins, W.A. -1.0157*
Tonn, R.J. -4.0070
Torblaa, R.L. -2.0205
Torgeson, D.C. -1.0069*
Toth, -2.0163
Toubangeau, P.C. -1.0297
Tourine, F.M. -2.0163*
Travis, B.V. -2.0067*, 2.0068*
Triplett, G.B. -1.0196*
Trpis, M. -4.0070
Tubb, R.A. -1.0300*, 1.0301*
Tuck, C. -1.0209*
Udey, L.R. -3.0116
Ukeles, R. -1.0326*
Ussary, J.P. -1.0172*
Vadas, R.L. -1.0336*, 2.0148*
Valliant, J. -1.0100*
Vance, B.J. -1.0233
Vanderborgh, N.E. -4.0021*
Vanhandel, E. -4.0049*
Vanlepik, J. -3.0029*
Veith, G.D. -1.0226
Viets, F.G. -1.0024*
Vind, H.P. -2.0267*
Volk, V.V. -1.0084*, 1.0085*
Voorhees, F.R. -4.0052
Waldron, A.C. -1.0191, 1.0193*
Walker, R. -3.0045*
Walker, R.L. -2.0050*
Walsh, D.F. -1.0282, 1.0283
Walsh, G.E. -1.0128*
Ward, R.A. -4.0046
Ware, F.J. -2.0192*, 2.0193*
Ware, G.W. -1.0007*
Warlen, S.M. -1.0299*
Warner, R.W. -3.0022
Warren, C.E. -1.0362*
Warren, J.W. -3.0104
Wasawo, D. -4.0059
Washburn, R.H. -2.0002*
Washino, R.K. -2.0010
Watts, J.G. -2.0164*
Webber, P.J. -1.0184*
Weber, D.T. -2.0190*
Wedemeyer, G. -1.0312*, 2.0234*, 3.0089*, 3.0090*, 3.0124*, 3.0125*
Weed, S.B. -1.0076*
Weidhaas, D.E. -2.0027*, 2.0033*
Weir, F.W. -1.0302*
Weir, P.A. -1.0302
Welch, E.B. -2.0180*
Weldon, L.W. -2.0116, 2.0118*, 2.0129*, 2.0186
Wellings, S.R. -3.0021*
Werner, R.G. -2.0219*
Wershaw, R.L. -1.0022*
Westgate, J. -3.0059
Westlake, W.E. -1.0018, 1.0019
Westley, R.E. -2.0293*, 3.0082
White, A.W. -1.0033*
White, E.M. -1.0092*
White, J.L. -1.0042*
White, R.L. -2.0232*
Whitley, J.R. -2.0154*, 2.0155*, 2.0156*, 2.0157*
Whitney, E.W. -2.0128
Whittlesey, N.E. -1.0104
Whitworth, W.R. -3.0025*
Wierenga, P.J. -1.0066*
Wiese, A. -1.0099*
Wilbur, R. -2.0128
Willford, W.W. -2.0261
Williams, G.C. -1.0113, 1.0229, 1.0230, 1.0231
Williams, S. -1.0233
Willis, G.H. -1.0050*
Willrich, T.L. -1.0045*
Wilson, A.J. -1.0129*
Wilson, B.H. -2.0040
Wilson, G.I. -2.0280
Wilson, H.A. -1.0220*
Wilson, R.F. -1.0122*
Wilson, S.U. -1.0132
Wingo, C.W. -2.0057*
Winterlin, W. -1.0322
Witt, A. -1.0366
Wolcott, A.R. -1.0057
Wolf, K.E. -3.0104*
Wolke, R. -3.0070*
Wolke, R.E. -3.0025
Woodard, F.E. -4.0011
Woodhouse, W.W. -1.0074
Woodwell, G.M. -1.0068*
Wooten, G.W. -1.0195*
Worthen, L.R. -1.0363*
Wright, J.F. -1.0184
Wright, J.W. -4.0070*
Wuderlich, W.E. -2.0147*
Yap, H.H. -1.0168
Yasuno, M. -4.0070
Yasutake, W.T. -3.0087, 3.0090, 3.0091*, 3.0092*, 3.0093*, 3.0094*, 3.0095*

*INDICATES PRINCIPAL INVESTIGATOR

INVESTIGATOR INDEX

Yates, M.L. -1.0215*
Yeo, R.R. -2.0100, 2.0101*, 2.0104*
Yermanos, D.M. -1.0017, 2.0017
Yoshida, R.N. -2.0131*
Zavortink, T.J. -4.0038
Zettler, F.W. -2.0121*, 2.0122*
Zinn, J. -3.0116
Zwerman, P.J. -1.0186*.

*INDICATES PRINCIPAL INVESTIGATOR

PERFORMING ORGANIZATION INDEX

Acad. of Nat. Sci. of Phila. ...*Philadelphia, Pennsylvania*, 2.0174.
Aerojet General Corporation ...*El Monte, California*, 1.0014, 1.0116, 1.0117, 1.0118, 1.0323.
Amer. Mosquito Control Assn. ...*Selma, California*, 4.0042.
Amer. Public Works Assn. ...*Chicago, Illinois*, 1.0142.
Analytical Biochemistry Labs. ...*Columbia, Missouri*, 1.0172.
Aquatic Sciences Incorporated ...*Boca Raton, Florida*, 1.0237.
Arizona State University ...*Tempe, Arizona*, 1.0005.
Athens College ...*Athens, Alabama*, 2.0091.
Auburn University ...*Auburn, Alabama*, 1.0001, 1.0002, 1.0228, 1.0319, 2.0001, 2.0092, 2.0093, 2.0094, 3.0001, 3.0002, 3.0003, 3.0004, 3.0005, 3.0006, 3.0007, 3.0008, 3.0009, 3.0010, 3.0011, 3.0012, 3.0013, 3.0014, 3.0015, 3.0016, 3.0017, 3.0108, 3.0109, 4.0001.
B. Thompson Inst. Plant Res. ...*Yonkers, New York*, 1.0069, 2.0070, 2.0071.
Battelle Memorial Institute ...*Richland, Washington*, 1.0106, 1.0107.
Bernice P. Bishop Museum ...*Honolulu, Hawaii*, 4.0050.
Bionomics Inc ...*Wareham, Massachusetts*, 1.0337.
Blackland Conserv. Res. Center ...*Temple, Texas*, 1.0101.
Brookhaven Natl. Lab. ...*Upton, New York*, 1.0068.
Cairo University ...*Cairo, United Arab Republic*, 2.0085.
Central Fla. Agric. Expt. Sta. ...*Sanford, Florida*, 1.0029.
Citrus Agricultural Expt. Sta. ...*Lake Alfred, Florida*, 2.0123.
City University of New York ...*Flushing, New York*, 2.0165.
Clemson University ...*Clemson, South Carolina*, 1.0091, 2.0081.
Colorado State University ...*Fort Collins, Colorado*, 1.0023, 1.0123.
Comm. Inst. of Biolog. Control ...*Bangalore, India*, 2.0135.
Comm. Inst. of Biolog. Control ...*Rawalpindi, Pakistan*, 2.0173.
Comm. Sci. & Indus. Res. Org. ...*Griffith, New South Wales, Australia*, 1.0010.
Cornell University ...*Ithaca, New York*, 1.0185, 2.0282.
Delaware River Basin Comm. ...*Trenton, New Jersey*, 1.0183, 1.0184.
Delta Branch Experiment Sta. ...*Stoneville, Mississippi*, 2.0056, 4.0064, 4.0065.
Detroit Lakes Engin. Dept. ...*Detroit Lakes, Minnesota*, 4.0015.
Dow Chemical Company ...*Midland, Michigan*, 2.0151.
Drexel University ...*Philadelphia, Pennsylvania*, 1.0198.
Duke University ...*Durham, North Carolina*, 1.0187.
East Carolina University ...*Greenville, North Carolina*, 1.0188, 3.0046, 3.0115.
Environmental Defense Fund ...*Riverhead, New York*, 2.0069.
Everglades Agric. Expt. Sta. ...*Belle Glade, Florida*, 2.0114.
Florida Agric. Expt. Station ...*Fort Lauderdale, Florida*, 2.0115.
Francis T. Nicholls State Coll ...*Thibodaux, Louisiana*, 2.0275.
Franklin Institute ...*Philadelphia, Pennsylvania*, 1.0199.
Georgetown University ...*Washington, District of Columbia*, 3.0026.
Georgia Agric. Expt. Sta. ...*Griffin, Georgia*, 1.0031.
Gulf Coast Pasture Cattle Sta. ...*Angleton, Texas*, 2.0082.
Gulf South Research Institute ...*Baton Rouge, Louisiana*, 1.0152.
Harvard University ...*Boston, Massachusetts*, 1.0255, 2.0277.
High Plains Research Found. ...*Plainview, Texas*, 1.0100.
Humboldt State College ...*Arcata, California*, 1.0320.
Illinois Inst. of Technology ...*Chicago, Illinois*, 4.0051.
Inst. for Plant Protection ...*Belgrade, Yugoslavia*, 2.0188.
Internat. Coun. of Sci. Unions ...*Zurich, Switzerland*, 1.0206.
Iowa State University ...*Ames, Iowa*, 1.0043, 1.0044, 1.0045, 1.0247, 2.0037, 4.0008, 4.0056, 4.0057.
Irrigation Ag. Res. & Ex. Ctr. ...*Prosser, Washington*, 2.0178.
Istituto Genetico ...*Cagliari, Italy*, 2.0038.
Jason M. Cortell & Associate ...*Natick, Massachusetts*, 2.0149.
Johns Hopkins University ...*Baltimore, Maryland*, 2.0047, 4.0061.
Justus Liebig Universitat ...*Giessen, Germany*, 2.0130.
Kansas State University ...*Manhattan, Kansas*, 1.0046, 1.0334.
Kent State University ...*Kent, Ohio*, 2.0287.
Laval University ...*Quebec City, Quebec, Canada*, 3.0023.
Lehigh University ...*Bethlehem, Pennsylvania*, 3.0061.
Louisiana State University ...*Baton Rouge, Louisiana*, 1.0049, 1.0050, 1.0249, 1.0250, 2.0040, 2.0041, 2.0139, 2.0140, 2.0141, 2.0142, 2.0143, 2.0144, 2.0145, 3.0028, 3.0029, 4.0010.
Louisiana State University ...*New Orleans, Louisiana*, 1.0153.
M S A Research Corporation ...*Evans City, Pennsylvania*, 1.0086.
Mahidol University ...*Bangkok, Thailand*, 4.0072.
McNeese State College ...*Lake Charles, Louisiana*, 2.0043, 2.0044, 2.0045.
Michigan State University ...*East Lansing, Michigan*, 1.0057, 1.0161, 1.0162, 1.0259, 1.0260, 1.0261, 1.0262, 1.0339, 1.0340, 1.0341, 1.0342, 1.0343, 1.0344, 1.0345, 2.0053, 2.0150.
Midwest Research Institute ...*Kansas City, Missouri*, 1.0060, 1.0180.
Monsanto Research Corporation ...*Dayton, Ohio*, 1.0195.
Montana State University ...*Bozeman, Montana*, 2.0058, 2.0059, 2.0158, 2.0159, 2.0160, 2.0161, 4.0080.
New Mexico State University ...*Las Cruces, New Mexico*, 1.0065, 1.0066, 2.0164, 4.0081.
New York State Agric. Sta. ...*Geneva, New York*, 2.0281.
North Dakota State University ...*Fargo, North Dakota*, 1.0077, 2.0076.
Ohio Agric. Res. & Dev. Center ...*Wooster, Ohio*, 1.0196.
Ohio State University ...*Columbus, Ohio*, 1.0078, 1.0191, 1.0192, 1.0193, 1.0300, 1.0301, 1.0302, 4.0026, 4.0027.
Okla. St. Univ. ...*Stillwater, Oklahoma*, 1.0081.
Oregon State University ...*Corvallis, Oregon*, 1.0082, 1.0083, 1.0084, 1.0085, 1.0303, 1.0304, 1.0305, 1.0360, 1.0361, 1.0362, 2.0077, 2.0078, 2.0167, 2.0288, 2.0289, 3.0048, 3.0049, 3.0050, 3.0051, 3.0052, 3.0053, 3.0054, 3.0055, 3.0056, 3.0116, 3.0117, 3.0118, 3.0119.
Penn. State University ...*University Park, Pennsylvania*, 1.0087, 1.0088, 1.0089, 1.0090, 1.0306, 2.0080.
Plantation Field Laboratory ...*Fort Lauderdale, Florida*, 2.0116.
Princeton University ...*Princeton, New Jersey*, 1.0182.
Providence College ...*Providence, Rhode Island*, 3.0071.
Purdue University ...*Lafayette, Indiana*, 1.0039, 1.0040, 1.0041, 1.0042, 1.0148, 1.0246, 2.0035, 2.0136, 4.0053, 4.0054.
Rensselaer Polytechnic Inst. ...*Troy, New York*, 3.0045.
Rice Pasture Res. & Ext. Ctr. ...*Beaumont, Texas*, 2.0176.
Rollins College ...*Winter Park, Florida*, 4.0006.
Rutgers the State University ...*New Brunswick, New Jersey*, 1.0064, 2.0060, 2.0061, 2.0062, 2.0162, 3.0114, 4.0019, 4.0020.
Saint Andrews Presby. College ...*Laurinburg, North Carolina*, 1.0070.
Skidaway Inst. of Oceanograph. ...*Savannah, Georgia*, 1.0140.
Smithsonian Institution ...*Washington, District of Columbia*, 2.0273.
South Dakota State University ...*Brookings, South Dakota*, 1.0092, 1.0203, 1.0204, 1.0205, 1.0364.
Southern Illinois University ...*Carbondale, Illinois*, 4.0007.
Stanford Research Institute ...*Menlo Park, California*, 1.0015, 4.0040.
State Board of Health ...*Indianapolis, Indiana*, 1.0147.
State Bur. of Water Management ...*Lansing, Michigan*, 1.0163.
State Conservation Department ...*Albany, New York*, 2.0219.
State Conservation Department ...*Cape Vincent, New York*, 2.0220.
State Conservation Department ...*Livingston Manor, New York*, 2.0223, 2.0224, 2.0225.
State Conservation Department ...*Rome, New York*, 3.0041, 3.0042, 3.0043.
State Dept. of Ches. Bay Afrs. ...*Annapolis, Maryland*, 4.0012.
State Dept. of Conserv. ...*Columbia, Missouri*, 2.0154.
State Dept. of Conserv. ...*Jefferson City, Missouri*, 1.0356, 2.0155, 2.0156, 2.0157, 3.0038.
State Dept. of Env. Conserv. ...*Cape Vincent, New York*, 2.0221, 2.0222, 4.0082.
State Dept. of Env. Conserv. ...*Rome, New York*, 3.0044.
State Dept. of Fish & Game ...*Sacramento, California*, 1.0235, 2.0103, 2.0189, 3.0022.
State Dept. of Fisheries ...*Olympia, Washington*, 2.0293, 3.0082.
State Dept. of Game ...*Olympia, Washington*, 1.0217, 1.0310, 1.0311.
State Dept. of Game & Fish ...*Santa Fe, New Mexico*, 2.0218.
State Dept. of Game Fish & Pk. ...*Pierre, South Dakota*, 2.0175.
State Dept. of In. Fish & Game ...*Augusta, Maine*, 2.0200, 3.0030.
State Dept. of In. Fish & Game ...*Bangor, Maine*, 2.0201.
State Dept. of Nat. Resources ...*Lansing, Michigan*, 1.0164.
State Dept. of Nat. Resources ...*Madison, Wisconsin*, 2.0263, 2.0264, 3.0106, 4.0086.
State Dept. of Pub. Health ...*Springfield, Illinois*, 1.0328.
State Dept. of Pub. Instruct. ...*Springfield, Illinois*, 1.0143.
State Dept. of Water Resources ...*Sacramento, California*, 2.0104.
State Div. of Env. Protection ...*Madison, Wisconsin*, 1.0221.

PERFORMING ORGANIZATION INDEX

State Div. of Fi. Gm. & Shfsh. ...*Trenton, New Jersey*, 2.0063, 2.0064, 2.0065, 2.0066, 2.0163.
State Div. of Fish & Game ...*Honolulu, Hawaii*, 2.0131.
State Div. of Fish & Wildlife ...*Dover, Delaware*, 2.0024, 2.0272.
State Div. of Fish & Wildlife ...*Indianapolis, Indiana*, 2.0199.
State Div. of Fisheries & Game ...*Westboro, Massachusetts*, 1.0156, 1.0157.
State Div. of Game & Fish ...*Tallahassee, Florida*, 2.0192, 2.0193.
State Div. of Game & Fish ...*Saint Paul, Minnesota*, 2.0153, 2.0212, 2.0213, 2.0214, 2.0215, 2.0216, 3.0035, 3.0036, 4.0079.
State Div. of Game Fish & Pks. ...*Fort Collins, Colorado*, 2.0190.
State Div. of Health ...*Vero Beach, Florida*, 4.0049.
State Div. of Oysters ...*Baton Rouge, Louisiana*, 2.0274.
State Div. of Wildlife ...*Ashley, Ohio*, 2.0227.
State Fish & Game Department ...*Boise, Idaho*, 2.0195, 2.0196, 2.0197, 4.0077.
State Fish & Game Department ...*Billings, Montana*, 3.0039.
State Fish & Wildlife Admin. ...*Annapolis, Maryland*, 3.0032.
State Fish Commission ...*Portland, Oregon*, 2.0228, 3.0057, 3.0058, 3.0059, 3.0060, 4.0083.
State Fish Commission ...*Harrisburg, Pennsylvania*, 3.0062, 3.0063, 3.0064, 3.0065, 3.0066, 3.0067, 3.0068.
State Fish Division ...*Lansing, Michigan*, 2.0202.
State Forest. Fish & Game Com. ...*Pratt, Kansas*, 1.0150, 2.0137, 4.0078.
State Game & Fish Commission ...*Atlanta, Georgia*, 2.0125, 2.0126, 2.0127, 2.0194, 4.0076.
State Game & Fish Commission ...*Cheyenne, Wyoming*, 3.0107, 3.0133, 3.0134.
State Game & Parks Commission ...*Lincoln, Nebraska*, 1.0298, 2.0217.
State Game Commission ...*Portland, Oregon*, 2.0229, 2.0230.
State Marine Conserv. Comm. ...*Biloxi, Mississippi*, 3.0037.
State Marine Resources Comm. ...*Newport News, Virginia*, 3.0077, 3.0078, 3.0079.
State Natural History Survey ...*Urbana, Illinois*, 1.0144, 1.0329, 1.0330.
State Parks & Wildlife Dept. ...*Austin, Texas*, 2.0231, 2.0232, 3.0072, 3.0073, 4.0084, 4.0085.
State Pollution Control Agency ...*Minneapolis, Minnesota*, 1.0166.
State Res. & Dev. Division ...*Lansing, Michigan*, 1.0263, 1.0264, 1.0346.
State University of New York ...*Ithaca, New York*, 1.0186, 2.0067, 2.0068, 2.0283, 4.0022, 4.0023, 4.0024.
State University of New York ...*Stony Brook, New York*, 2.0166.
State University of New York ...*Syracuse, New York*, 1.0067.
State Water Development Board ...*Austin, Texas*, 1.0209.
State Water Pollution Control ...*Frankfort, Kentucky*, 4.0009.
State Wildlife & Fish Comm. ...*Baton Rouge, Louisiana*, 1.0251, 3.0111, 3.0112.
State Wildlife Resources Comm. ...*Raleigh, North Carolina*, 2.0226.
Texas A & M University System ...*College Station, Texas*, 1.0095, 1.0096, 1.0097, 1.0098, 1.0099, 1.0211, 1.0365, 3.0074, 3.0075, 3.0076.
Texas Res. Foundation ...*Renner, Texas*, 4.0028.
Tuskegee Institute ...*Tuskegee Institute, Alabama*, 1.0003.
U.S. Air Force ...*San Antonio, Texas*, 2.0084.
U.S. Army ...*Fort Clayton, Canal Zone*, 4.0043.
U.S. Army ...*Washington, District of Columbia*, 4.0046.
U.S. Army ...*Zama Honshu, Japan*, 4.0058.
U.S. Army ...*New Orleans, Louisiana*, 2.0147.
U.S. Army ...*Vicksburg, Mississippi*, 1.0171.
U.S. Army ...*San Antonio, Texas*, 4.0071.
U.S. Dept. of Agriculture ...*Buenos Aires, Argentina*, 2.0095.
U.S. Dept. of Agriculture ...*Flagstaff, Arizona*, 1.0004.
U.S. Dept. of Agriculture ...*Stuttgart, Arkansas*, 2.0098.
U.S. Dept. of Agriculture ...*Albany, California*, 2.0099.
U.S. Dept. of Agriculture ...*Davis, California*, 2.0100.
U.S. Dept. of Agriculture ...*Fresno, California*, 2.0011.
U.S. Dept. of Agriculture ...*Denver, Colorado*, 2.0105, 4.0045.
U.S. Dept. of Agriculture ...*Fort Collins, Colorado*, 1.0024.
U.S. Dept. of Agriculture ...*Washington, District of Columbia*, 1.0026, 1.0124.
U.S. Dept. of Agriculture ...*Fort Lauderdale, Florida*, 2.0117, 2.0118.
U.S. Dept. of Agriculture ...*Gainesville, Florida*, 2.0026, 2.0027, 4.0047.
U.S. Dept. of Agriculture ...*Savannah, Georgia*, 2.0129.
U.S. Dept. of Agriculture ...*Watkinsville, Georgia*, 1.0032, 1.0033.
U.S. Dept. of Agriculture ...*Peoria, Illinois*, 2.0198.
U.S. Dept. of Agriculture ...*Beltsville, Maryland*, 1.0052, 1.0053, 1.0054, 2.0049, 2.0050.
U.S. Dept. of Agriculture ...*Oxford, Mississippi*, 1.0170.
U.S. Dept. of Agriculture ...*Las Cruces, New Mexico*, 2.0280.
U.S. Dept. of Agriculture ...*Coshocton, Ohio*, 1.0194.
U.S. Dept. of Agriculture ...*Durant, Oklahoma*, 1.0080.
U.S. Dept. of Agriculture ...*Corvallis, Oregon*, 2.0079.
U.S. Dept. of Agriculture ...*Bushland, Texas*, 1.0094.
U.S. Dept. of Agriculture ...*Kerrville, Texas*, 1.0212.
U.S. Dept. of Agriculture ...*Madison, Wisconsin*, 2.0295, 2.0296.
U.S. Dept. of Commerce ...*Auke Bay, Alaska*, 1.0232.
U.S. Dept. of Commerce ...*Milford, Connecticut*, 1.0236, 1.0326, 2.0271.
U.S. Dept. of Commerce ...*Gulf Breeze, Florida*, 1.0127, 1.0128, 1.0129, 1.0238, 1.0239, 1.0240, 1.0241, 1.0242.
U.S. Dept. of Commerce ...*Oxford, Maryland*, 3.0033, 3.0034, 3.0113.
U.S. Dept. of Commerce ...*Ann Arbor, Michigan*, 1.0160, 1.0256, 1.0338.
U.S. Dept. of Commerce ...*Lundington, Michigan*, 2.0203.
U.S. Dept. of Commerce ...*Marquette, Michigan*, 2.0204, 2.0205, 2.0206, 2.0207, 2.0208, 2.0209.
U.S. Dept. of Commerce ...*Millersburg, Michigan*, 2.0210, 2.0211.
U.S. Dept. of Commerce ...*Highlands, New Jersey*, 3.0040.
U.S. Dept. of Commerce ...*Beaufort, North Carolina*, 1.0299.
U.S. Dept. of Commerce ...*Seattle, Washington*, 3.0083.
U.S. Dept. of Commerce ...*Ashland, Wisconsin*, 2.0235.
U.S. Dept. of Hlth. Ed. & Wel. ...*Bethesda, Maryland*, 2.0051, 2.0276, 4.0062.
U.S. Dept. of Hlth. Ed. & Wel. ...*Narragansett, Rhode Island*, 2.0291.
U.S. Dept. of the Interior ...*Marion, Alabama*, 1.0113, 1.0114, 1.0229, 1.0230, 1.0231.
U.S. Dept. of the Interior ...*Stuttgart, Arkansas*, 3.0020.
U.S. Dept. of the Interior ...*Belvedere, California*, 1.0234.
U.S. Dept. of the Interior ...*Menlo Park, California*, 1.0119, 1.0120, 4.0002.
U.S. Dept. of the Interior ...*Denver, Colorado*, 1.0022, 1.0122, 1.0325, 2.0106, 2.0107, 2.0108, 2.0109, 2.0110, 2.0111, 2.0112, 4.0003.
U.S. Dept. of the Interior ...*Washington, District of Columbia*, 1.0125.
U.S. Dept. of the Interior ...*Tallahassee, Florida*, 1.0134.
U.S. Dept. of the Interior ...*Athens, Georgia*, 1.0135.
U.S. Dept. of the Interior ...*Atlanta, Georgia*, 2.0128.
U.S. Dept. of the Interior ...*Boise, Idaho*, 2.0132.
U.S. Dept. of the Interior ...*Columbia, Missouri*, 1.0173, 1.0174, 1.0175, 1.0176, 1.0267, 1.0268, 1.0269, 1.0270, 1.0271, 1.0272, 1.0273, 1.0274, 1.0275, 1.0276, 1.0277, 1.0278, 1.0279, 1.0280, 1.0281, 1.0282, 1.0283, 1.0284, 1.0285, 1.0286, 1.0287, 1.0288, 1.0289, 1.0290, 1.0291, 1.0292, 1.0293, 1.0294, 1.0295, 1.0296, 1.0348, 1.0349, 1.0350, 1.0351, 1.0352, 1.0353, 1.0354, 1.0355.
U.S. Dept. of the Interior ...*Ada, Oklahoma*, 1.0079.
U.S. Dept. of the Interior ...*Arlington, Virginia*, 1.0215.
U.S. Dept. of the Interior ...*Cook, Washington*, 1.0309, 3.0080, 3.0081.
U.S. Dept. of the Interior ...*Longview, Washington*, 2.0177, 3.0120.
U.S. Dept. of the Interior ...*Seattle, Washington*, 1.0312, 2.0234, 3.0084, 3.0085, 3.0086, 3.0087, 3.0088, 3.0089, 3.0090, 3.0091, 3.0092, 3.0093, 3.0094, 3.0095, 3.0121, 3.0122, 3.0123, 3.0124, 3.0125.
U.S. Dept. of the Interior ...*Kearneysville, West Virginia*, 3.0096, 3.0097, 3.0098, 3.0099, 3.0100, 3.0101, 3.0102, 3.0103, 3.0104, 3.0127, 3.0128, 3.0129.
U.S. Dept. of the Interior ...*Leetown, West Virginia*, 3.0105, 3.0130, 3.0131, 3.0132.
U.S. Dept. of the Interior ...*La Crosse, Wisconsin*, 1.0108, 1.0314, 1.0315, 1.0316, 1.0366, 2.0236, 2.0237, 2.0238, 2.0239, 2.0240, 2.0241, 2.0242, 2.0243, 2.0244, 2.0245, 2.0246, 2.0247, 2.0248, 2.0249, 2.0250, 2.0251, 2.0252, 2.0253, 2.0254, 2.0255, 2.0256, 2.0257, 2.0258, 2.0259, 2.0260, 2.0261, 2.0262.
U.S. Dept. of the Interior ...*Jackson, Wyoming*, 1.0318.
U.S. Environ. Protection Agcy. ...*Athens, Georgia*, 1.0136.
U.S. Environ. Protection Agcy. ...*Duluth, Minnesota*, 1.0165, 1.0347.
U.S. Environ. Protection Agcy. ...*Ada, Oklahoma*, 1.0197.
U.S. Environ. Protection Agcy. ...*Corvallis, Oregon*, 2.0168, 2.0169, 2.0170, 2.0171, 2.0172.
U.S. Environ. Protection Agcy. ...*West Kingston, Rhode Island*, 1.0307.
U.S. Navy ...*Port Hueneme, California*, 1.0121, 2.0267.
U.S. Navy ...*Pensacola, Florida*, 2.0191.
U.S. Navy ...*New York, New York*, 4.0067.
U.S. Navy ...*Jacksonville, North Carolina*, 2.0074.
U.S. Navy ...*Taipei, Republic of China*, 4.0068.
Union Carbide Corporation ...*Tarrytown, New York*, 1.0357.
Univ. Do Brasil ...*Rio De Janeiro, Brazil*, 2.0266.
Univ. Nac. De Colombia ...*Bogota, Colombia*, 4.0044.
Univ. of Akron ...*Akron, Ohio*, 2.0284, 2.0285, 2.0286.
Univ. of Alaska ...*Palmer, Alaska*, 2.0002.
Univ. of Arizona ...*Tucson, Arizona*, 1.0006, 1.0007, 2.0096, 4.0031.
Univ. of Arkansas ...*Fayetteville, Arkansas*, 1.0008, 1.0009, 2.0003, 2.0004, 2.0005, 2.0097, 3.0018, 3.0019, 4.0032.
Univ. of California ...*Berkeley, California*, 1.0011, 1.0321, 2.0006, 2.0007, 2.0008, 4.0033, 4.0034, 4.0035.
Univ. of California ...*Davis, California*, 1.0012, 1.0013, 1.0115, 1.0322, 2.0009, 2.0010, 2.0101, 3.0021.
Univ. of California ...*Los Angeles, California*, 2.0012, 2.0013, 4.0036, 4.0037, 4.0038.
Univ. of California ...*Riverside, California*, 1.0016, 1.0017, 1.0018, 1.0019, 1.0020, 1.0021, 1.0324, 2.0014, 2.0015, 2.0016, 2.0017, 2.0018, 2.0019, 2.0020, 2.0102, 2.0268, 2.0269.
Univ. of California ...*San Francisco, California*, 2.0270, 4.0041.
Univ. of Cincinnati ...*Cincinnati, Ohio*, 1.0190.
Univ. of Connecticut ...*Storrs, Connecticut*, 2.0022, 2.0023, 2.0113, 3.0024, 3.0025.
Univ. of Delaware ...*Newark, Delaware*, 1.0025, 1.0327, 2.0025, 4.0004.
Univ. of East Africa ...*Nairobi, Univ. College, Kenya*, 4.0059.

PERFORMING ORGANIZATION INDEX

Univ. of Florida ...*Gainesville, Florida*, 1.0027, 1.0028, 1.0126, 2.0028, 2.0029, 2.0030, 2.0031, 2.0032, 2.0033, 2.0119, 2.0120, 2.0121, 2.0122, 4.0005, 4.0048.
Univ. of Georgia ...*Athens, Georgia*, 1.0030, 1.0137, 1.0138, 1.0245.
Univ. of Georgia ...*Sapelo Island, Georgia*, 1.0139.
Univ. of Hawaii ...*Honolulu, Hawaii*, 1.0034, 1.0035, 1.0036.
Univ. of Hawaii ...*Kaneohe, Hawaii*, 3.0110.
Univ. of Idaho ...*Moscow, Idaho*, 1.0141.
Univ. of Illinois ...*Chicago, Illinois*, 2.0133, 2.0134.
Univ. of Illinois ...*Urbana, Illinois*, 1.0037, 1.0038, 1.0145, 1.0146, 1.0331, 1.0332, 1.0333, 2.0034, 4.0052.
Univ. of Iowa ...*Iowa City, Iowa*, 1.0149.
Univ. of Kentucky ...*Lexington, Kentucky*, 1.0047, 1.0048, 1.0151, 2.0039, 2.0138.
Univ. of Louisville ...*Louisville, Kentucky*, 1.0248.
Univ. of Maine ...*Orono, Maine*, 1.0051, 1.0252, 1.0335, 1.0336, 2.0046, 2.0148, 3.0031, 4.0011.
Univ. of Malaya ...*Kuala Lumpur, Malaysia*, 4.0060.
Univ. of Manitoba ...*Winnipeg, Manitoba, Canada*, 2.0021.
Univ. of Maryland ...*Baltimore, Maryland*, 2.0048.
Univ. of Maryland ...*College Park, Maryland*, 1.0154, 4.0013, 4.0063.
Univ. of Massachusetts ...*Amherst, Massachusetts*, 1.0055, 1.0056, 1.0155, 1.0253, 1.0254, 2.0052, 4.0014.
Univ. of Miami ...*Miami, Florida*, 1.0130, 1.0131, 1.0132, 1.0243, 1.0244, 2.0124, 3.0027.
Univ. of Michigan ...*Ann Arbor, Michigan*, 1.0257, 1.0258, 2.0278, 2.0279.
Univ. of Minnesota ...*Minneapolis, Minnesota*, 1.0167, 2.0152, 4.0016, 4.0017.
Univ. of Minnesota ...*Saint Paul, Minnesota*, 1.0168, 1.0265, 1.0266, 2.0054, 2.0055.
Univ. of Missouri ...*Columbia, Missouri*, 1.0058, 1.0059, 1.0177, 1.0178, 1.0179, 2.0057.
Univ. of Missouri ...*Rolla, Missouri*, 1.0181.
Univ. of Montana ...*Missoula, Montana*, 1.0297, 4.0066.
Univ. of Nebraska ...*Lincoln, Nebraska*, 1.0061.
Univ. of Nevada ...*Reno, Nevada*, 1.0062, 1.0063.
Univ. of New Hampshire ...*Durham, New Hampshire*, 4.0018.
Univ. of New Mexico ...*Albuquerque, New Mexico*, 4.0021.
Univ. of North Carolina ...*Chapel Hill, North Carolina*, 2.0072, 2.0073.
Univ. of North Carolina ...*Raleigh, North Carolina*, 1.0071, 1.0072, 1.0073, 1.0074, 1.0075, 1.0076, 1.0189, 1.0358, 2.0075, 3.0047.
Univ. of North Dakota ...*Grand Forks, North Dakota*, 1.0359, 4.0025.
Univ. of Notre Dame ...*Notre Dame, Indiana*, 2.0036, 4.0055.
Univ. of Queensland ...*Saint Lucia, Brisbane, Australia*, 1.0233.
Univ. of Rhode Island ...*Kingston, Rhode Island*, 1.0200, 1.0201, 1.0202, 1.0363, 2.0290, 3.0069, 3.0070, 4.0069.
Univ. of Southern California ...*Los Angeles, California*, 4.0039.
Univ. of Southwestern La. ...*Lafayette, Louisiana*, 2.0042, 2.0146.
Univ. of Tennessee ...*Knoxville, Tennessee*, 1.0207.
Univ. of Tennessee ...*Martin, Tennessee*, 1.0208.
Univ. of Texas ...*Austin, Texas*, 1.0093, 1.0210.
Univ. of Texas ...*Houston, Texas*, 2.0083.
Univ. of Vermont ...*Burlington, Vermont*, 1.0213, 1.0214.
Univ. of Washington ...*Seattle, Washington*, 1.0313, 2.0180, 3.0126.
Univ. of West Florida ...*Pensacola, Florida*, 1.0133.
Univ. of Wisconsin ...*Madison, Wisconsin*, 1.0109, 1.0110, 1.0111, 1.0112, 1.0222, 1.0223, 1.0224, 1.0225, 1.0226, 1.0317, 1.0367, 1.0368, 2.0087, 2.0088, 2.0089, 2.0181, 2.0182, 2.0183, 2.0184, 2.0185, 2.0265, 4.0030, 4.0075.
Univ. of Wisconsin ...*Milwaukee, Wisconsin*, 1.0227.
Univ. of Wyoming ...*Laramie, Wyoming*, 2.0090, 2.0186, 2.0187.
Utah State University ...*Logan, Utah*, 1.0102, 1.0103, 2.0086, 2.0292, 4.0029.
Virginia Inst. of Marine Sci. ...*Gloucester Point, Virginia*, 2.0233.
Virginia Polytechnic Institute ...*Blacksburg, Virginia*, 1.0216, 1.0308, 4.0073.
Washington State University ...*Pullman, Washington*, 1.0104, 1.0105, 1.0218, 1.0219, 2.0179, 2.0294, 4.0074.
West Va. University ...*Morgantown, West Virginia*, 1.0220.
Winona State College ...*Winona, Minnesota*, 1.0169.
Woods Hole Oceanographic Inst. ...*Woods Hole, Massachusetts*, 1.0158, 1.0159.
World Health Organization ...*Geneva, Switzerland*, 4.0070.

SUPPORTING AGENCY INDEX

Alabama State Government
1.0319, 3.0015.
Amer. Assn. for the Advancement of Sci.
4.0026.
Arizona State Government
1.0007.
Arkansas State Government - Little Rock
1.0008, 2.0004, 2.0097.
Australian Government - Canberra
1.0010.
California State Government - Sacramento
1.0018, 1.0020, 1.0320, 1.0321, 1.0324, 2.0006, 2.0007, 2.0008, 2.0010, 2.0014, 2.0015, 2.0016, 2.0018, 2.0019, 2.0268, 2.0269, 4.0033, 4.0035.
Canadian Government - Ottawa
3.0023.
Connecticut State Government - Hartford
1.0226, 2.0023, 2.0113, 3.0024, 3.0025.
Delaware River Basin Comm. - Washington
1.0184.
Delaware State Government
1.0327, 2.0025.
Florida State Government - Tallahassee
2.0031, 2.0114, 2.0116, 2.0122, 2.0123, 2.0130.
Ford Foundation - New York, N.Y.
1.0206, 2.0069, 2.0285.
Hercules Incorporated - Wilmington, Del.
1.0139.
Illinois State Government - Springfield
1.0332.
Indiana State Government
2.0136, 4.0053.
Intl. Atomic Energy Agency - Austria
1.0111.
Iowa State Government - Des Moines
1.0045, 4.0008, 4.0056, 4.0057.
Louisiana State Government - Baton Rouge
1.0049, 1.0249, 2.0139, 2.0140, 2.0142, 2.0143, 2.0145, 3.0028.
Maryland State Government
4.0013, 4.0063.
Massachusetts State Government
1.0156, 2.0149.
Michigan State Government - Lansing
1.0259, 1.0261, 1.0341.
Mississippi State Government
2.0056, 4.0064.
Montana State Government - Helena
2.0058, 2.0059, 4.0080.
Natl. Geographic Soc. - Washington, D.C.
2.0287.
New Jersey State Government - Trenton
1.0064, 2.0060, 2.0061, 3.0114.
New Mexico State Government
4.0081.
New York State Government - Albany
2.0068, 2.0281, 2.0283.
No Formal Support Reported
3.0046.
North Carolina State Government - Raleigh
1.0074, 1.0075.
North Dakota State Government
2.0076.
Ohio State Government
1.0192.
Oregon State Government - Salem
1.0085, 1.0303, 1.0305, 1.0360, 2.0078, 2.0167, 2.0288, 2.0289, 3.0049, 3.0050, 3.0051, 3.0052, 3.0054, 3.0056, 3.0117, 3.0119.
Pennsylvania State Government
2.0080.
Research Corporation - New York, N.Y.
1.0070.
Rhode Island State Government
1.0202, 3.0069.
Rockefeller Foundation - New York, N.Y.
4.0059.
Smithsonian Institution
2.0273.
Society of the Sigma Xi - New Haven, Conn.
3.0061.
South Dakota State Government - Pierre
1.0203, 1.0364.
Texas State Government - Austin
1.0100, 1.0209, 1.0365, 2.0082, 2.0176.
U.S. Atomic Energy Commission
1.0068, 1.0078, 2.0036, 3.0126.
U.S. Dept. of Agriculture - A.R.S. - A.D.P
1.0032, 1.0052.
U.S. Dept. of Agriculture - A.R.S. - C.R.
1.0004, 1.0015, 1.0071, 1.0106, 1.0107, 2.0098, 2.0101, 2.0105, 2.0115, 2.0117, 2.0118, 2.0124, 2.0129, 2.0160, 2.0178, 2.0187.
U.S. Dept. of Agriculture - A.R.S. - E.N.T
2.0009, 2.0011, 2.0020, 2.0028, 2.0029, 2.0030, 2.0033, 2.0042, 2.0043, 2.0044, 2.0045, 2.0049, 2.0050, 2.0079, 2.0085, 2.0095, 2.0099, 2.0120, 2.0135, 2.0144, 2.0173, 2.0188, 4.0045, 4.0048, 4.0065.
U.S. Dept. of Agriculture - A.R.S. - S.W.C
1.0011, 1.0021, 1.0024, 1.0033, 1.0050, 1.0051, 1.0053, 1.0054, 1.0080, 1.0094, 1.0098, 1.0099, 1.0101, 1.0109, 1.0170, 1.0194.
U.S. Dept. of Agriculture - A.R.S. - U.R.N
2.0198.
U.S. Dept. of Agriculture - A.R.S. - V.S.R
1.0212, 2.0280.
U.S. Dept. of Agriculture - C.S.R.S.
1.0002, 1.0006, 1.0009, 1.0013, 1.0017, 1.0019, 1.0023, 1.0025, 1.0027, 1.0029, 1.0030, 1.0031, 1.0034, 1.0035, 1.0037, 1.0038, 1.0039, 1.0040, 1.0042, 1.0043, 1.0046, 1.0047, 1.0048, 1.0055, 1.0056, 1.0058, 1.0059, 1.0061, 1.0062, 1.0063, 1.0065, 1.0072, 1.0073, 1.0076, 1.0077, 1.0081, 1.0082, 1.0084, 1.0087, 1.0088, 1.0089, 1.0090, 1.0091, 1.0092, 1.0095, 1.0096, 1.0097, 1.0103, 1.0105, 1.0138, 1.0141, 1.0145, 1.0179, 1.0182, 1.0196, 1.0213, 1.0220, 1.0246, 1.0250, 1.0260, 1.0266, 1.0306, 1.0334, 1.0335, 1.0339, 1.0340, 1.0342, 1.0343, 1.0344, 1.0362, 2.0001, 2.0002, 2.0005, 2.0022, 2.0037, 2.0039, 2.0040, 2.0046, 2.0052, 2.0053, 2.0054, 2.0055, 2.0057, 2.0062, 2.0067, 2.0077, 2.0081, 2.0089, 2.0093, 2.0094, 2.0096, 2.0102, 2.0141, 2.0148, 2.0161, 2.0162, 2.0184, 2.0185, 3.0001, 3.0031, 3.0047, 3.0108, 4.0005, 4.0010, 4.0014, 4.0020, 4.0022, 4.0024, 4.0031, 4.0032, 4.0034, 4.0069.
U.S. Dept. of Agriculture - E.R.S.
1.0026.
U.S. Dept. of Agriculture - F.S.
1.0005, 1.0067, 1.0083.
U.S. Dept. of Commerce - N.O.A.A.
1.0112, 1.0127, 1.0128, 1.0129, 1.0133, 1.0160, 1.0232, 1.0236, 1.0238, 1.0239, 1.0240, 1.0241, 1.0242, 1.0256, 1.0299, 1.0317, 1.0326, 1.0338, 1.0358, 2.0202, 2.0203, 2.0204, 2.0205, 2.0206, 2.0207, 2.0208, 2.0209, 2.0210, 2.0211, 2.0235, 2.0264, 2.0271, 2.0274, 3.0022, 3.0027, 3.0032, 3.0033, 3.0034, 3.0040, 3.0053, 3.0055, 3.0059, 3.0060, 3.0070, 3.0074, 3.0075, 3.0076, 3.0077, 3.0078, 3.0079, 3.0082, 3.0083, 3.0106, 3.0110, 3.0113, 3.0118, 4.0012.
U.S. Dept. of Defense - Air Force
2.0084, 4.0044.
U.S. Dept. of Defense - Army
1.0155, 1.0171, 2.0021, 2.0026, 2.0027, 2.0086, 2.0091, 2.0092, 2.0128, 2.0146, 2.0147, 2.0186, 2.0266, 2.0284, 4.0037, 4.0040, 4.0041, 4.0043, 4.0046, 4.0047, 4.0051, 4.0054, 4.0058, 4.0060, 4.0071, 4.0072.
U.S. Dept. of Defense - Navy
1.0121, 2.0074, 2.0191, 2.0267, 2.0295, 2.0296, 4.0067, 4.0068.
U.S. Dept. of Hlth. Ed. & Wel. - C.P.E.H.
1.0057, 1.0304.

SUPPORTING AGENCY INDEX

U.S. Dept. of Hlth. Ed. & Wel. - E.H.S.
1.0003, 2.0291.

U.S. Dept. of Hlth. Ed. & Wel. - H.S.M.H.A
2.0013, 2.0017, 2.0032, 2.0083, 4.0052, 4.0070, 4.0075.

U.S. Dept. of Hlth. Ed. & Wel. - N.I.H.
1.0190, 1.0255, 1.0322, 1.0361, 2.0012, 2.0034, 2.0035, 2.0038, 2.0041, 2.0047, 2.0048, 2.0070, 2.0071, 2.0072, 2.0270, 2.0276, 2.0277, 2.0286, 3.0021, 3.0045, 4.0036, 4.0038, 4.0039, 4.0042, 4.0049, 4.0050, 4.0055, 4.0061, 4.0062.

U.S. Dept. of Interior - Bu. Comm. Fish.
2.0212, 2.0293, 3.0037, 3.0038, 3.0073.

U.S. Dept. of Interior - Bu. Reclamation
1.0122, 2.0100, 2.0104, 2.0106, 2.0107, 2.0108, 2.0109, 2.0110, 2.0111, 2.0112, 2.0132, 2.0158, 2.0159, 2.0164, 4.0003.

U.S. Dept. of Interior - Bu. Sport Fish.
1.0108, 1.0113, 1.0114, 1.0150, 1.0173, 1.0174, 1.0175, 1.0176, 1.0217, 1.0229, 1.0230, 1.0231, 1.0234, 1.0235, 1.0245, 1.0251, 1.0252, 1.0253, 1.0263, 1.0264, 1.0267, 1.0268, 1.0269, 1.0270, 1.0271, 1.0272, 1.0273, 1.0274, 1.0275, 1.0276, 1.0277, 1.0278, 1.0279, 1.0280, 1.0281, 1.0282, 1.0283, 1.0284, 1.0285, 1.0286, 1.0287, 1.0288, 1.0289, 1.0290, 1.0291, 1.0292, 1.0293, 1.0294, 1.0295, 1.0296, 1.0298, 1.0300, 1.0301, 1.0309, 1.0310, 1.0311, 1.0312, 1.0314, 1.0315, 1.0316, 1.0318, 1.0325, 1.0346, 1.0348, 1.0349, 1.0350, 1.0351, 1.0352, 1.0353, 1.0354, 1.0355, 1.0356, 1.0366, 2.0024, 2.0063, 2.0064, 2.0065, 2.0066, 2.0103, 2.0125, 2.0126, 2.0127, 2.0131, 2.0137, 2.0153, 2.0155, 2.0156, 2.0157, 2.0163, 2.0175, 2.0177, 2.0189, 2.0190, 2.0192, 2.0193, 2.0194, 2.0195, 2.0196, 2.0197, 2.0199, 2.0200, 2.0201, 2.0213, 2.0214, 2.0215, 2.0216, 2.0217, 2.0218, 2.0219, 2.0220, 2.0221, 2.0222, 2.0223, 2.0224, 2.0225, 2.0226, 2.0227, 2.0228, 2.0229, 2.0230, 2.0231, 2.0232, 2.0234, 2.0236, 2.0237, 2.0238, 2.0239, 2.0240, 2.0241, 2.0242, 2.0243, 2.0244, 2.0245, 2.0246, 2.0247, 2.0248, 2.0249, 2.0250, 2.0251, 2.0252, 2.0253, 2.0254, 2.0255, 2.0256, 2.0257, 2.0258, 2.0259, 2.0260, 2.0261, 2.0262, 2.0263, 2.0272, 2.0292, 3.0002, 3.0003, 3.0004, 3.0005, 3.0006, 3.0007, 3.0008, 3.0009, 3.0010, 3.0011, 3.0012, 3.0013, 3.0014, 3.0016, 3.0017, 3.0020, 3.0030, 3.0035, 3.0036, 3.0039, 3.0041, 3.0042, 3.0043, 3.0044, 3.0057, 3.0058, 3.0062, 3.0063, 3.0064, 3.0065, 3.0066, 3.0067, 3.0068, 3.0072, 3.0080, 3.0081, 3.0084, 3.0085, 3.0086, 3.0087, 3.0088, 3.0089, 3.0090, 3.0091, 3.0092, 3.0093, 3.0094, 3.0095, 3.0096, 3.0097, 3.0098, 3.0099, 3.0100, 3.0101, 3.0102, 3.0103, 3.0104, 3.0105, 3.0107, 3.0109, 3.0111, 3.0112, 3.0120, 3.0121, 3.0122, 3.0123, 3.0124, 3.0125, 3.0127, 3.0128, 3.0129, 3.0130, 3.0131, 3.0132, 3.0133, 3.0134, 4.0076, 4.0077, 4.0078, 4.0079, 4.0082, 4.0083, 4.0084, 4.0085, 4.0086.

U.S. Dept. of Interior - F. Wtr. Qua. Adm.
1.0012, 1.0079, 1.0115, 1.0126, 1.0135, 1.0207, 1.0210, 1.0228, 1.0313, 2.0279, 4.0015.

U.S. Dept. of Interior - Geological Survey
1.0022, 1.0119, 1.0120, 1.0134, 1.0215, 4.0002.

U.S. Dept. of Interior - O. Wtr. Res. Rch.
1.0001, 1.0028, 1.0036, 1.0041, 1.0044, 1.0066, 1.0148, 1.0149, 1.0151, 1.0154, 1.0161, 1.0162, 1.0177, 1.0181, 1.0185, 1.0187, 1.0188, 1.0189, 1.0191, 1.0200, 1.0201, 1.0205, 1.0208, 1.0211, 1.0216, 1.0223, 1.0247, 1.0248, 1.0258, 1.0262, 1.0297, 1.0329, 1.0333, 1.0336, 1.0345, 1.0359, 1.0363, 2.0003, 2.0073, 2.0075, 2.0119, 2.0121, 2.0133, 2.0134, 2.0138, 2.0150, 2.0152, 2.0180, 2.0181, 2.0183, 2.0290, 3.0018, 3.0019, 3.0071, 4.0001, 4.0004, 4.0006, 4.0011, 4.0016, 4.0018, 4.0019, 4.0021, 4.0023, 4.0027, 4.0029.

U.S. Dept. of Interior - Off. Saline Water
1.0153.

U.S. Dept. of State
2.0051.

U.S. Environ. Protect. Agency - O.O.W.P.
1.0014, 1.0016, 1.0060, 1.0069, 1.0086, 1.0093, 1.0102, 1.0104, 1.0116, 1.0117, 1.0118, 1.0124, 1.0125, 1.0136, 1.0137, 1.0142, 1.0143, 1.0144, 1.0147, 1.0157, 1.0159, 1.0163, 1.0164, 1.0165, 1.0166, 1.0167, 1.0169, 1.0172, 1.0178, 1.0180, 1.0183, 1.0186, 1.0193, 1.0195, 1.0197, 1.0198, 1.0199, 1.0204, 1.0214, 1.0219, 1.0221, 1.0225, 1.0227, 1.0237, 1.0243, 1.0254, 1.0257, 1.0265, 1.0302, 1.0307, 1.0323, 1.0328, 1.0330, 1.0337, 1.0347, 1.0357, 2.0151, 2.0154, 2.0168, 2.0169, 2.0170, 2.0171, 2.0172, 2.0174, 2.0278, 3.0116, 4.0009, 4.0017, 4.0025, 4.0028, 4.0030, 4.0066.

U.S. Environ. Protect. Agency - W.Q.O.
1.0168, 1.0244.

U.S. National Science Foundation
1.0123, 1.0130, 1.0131, 1.0140, 1.0146, 1.0152, 1.0158, 2.0165, 2.0166, 2.0275, 2.0282, 3.0026, 3.0029, 3.0048, 4.0007.

U.S. Natl. Aero. & Space Adm.
1.0132.

University of Illinois
1.0331.

University of North Carolina
3.0115.

University of Queensland - Brisbane, Aust.
1.0233.

Virginia Inst. of Marine Sci. - Virginia
2.0233.

Virginia State Government
1.0308, 4.0073.

Washington State Government - Olympia
1.0218, 2.0179, 2.0294, 4.0074.

Wisconsin State Government - Madison
1.0110, 1.0222, 1.0224, 1.0367, 1.0368, 2.0087, 2.0088, 2.0182, 2.0265.

Wyoming State Government - Cheyenne
2.0090.

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